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Automated biomechanical analysis system for detection and correction of postural deviations in patients and for providing posture health care through distributed system (Eng)

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Novelty: Marker positions are selected, referenced with respect to the anatomy of the patient and a scannable marker is fixed to the patient at each point. The patient is then placed in a relaxed and normal standing posture and the markers are scanned to obtain position data for each of the marker positions. The data are used to calculate postural deviation values.

Detailed Description: INDEPENDENT CLAIMS are included for the following:

- (1) a method of acquiring biomechanical postural data;
- (2) a method and apparatus for calculating postural deviation;
- (3) an apparatus for providing postural health care.

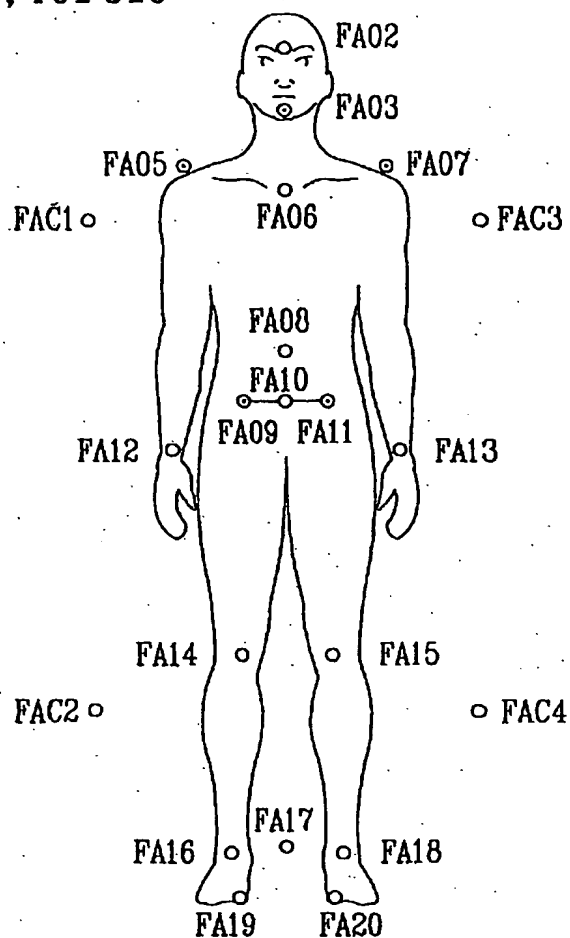
Use: Automated biomechanical analysis for detection and correction of postural deviations.

Description of Drawing(s): The drawing shows anatomical marker locations in an anterior view.

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(54) Title: SYSTEM AND METHOD FOR AUTOMATED BIOMECHANICAL ANALYSIS AND THE DETECTION AND COR-
RECTION OF POSTURAL DEVIATIONS(57) Abstract: The present invention relates to a method and apparatus of acquiring biomechanical position data for use in postural
analysis. The present invention also relates to a method and apparatus for calculating postural deviation values in a patient. The
present invention further relates to a method and apparatus of providing posture health care using a distributed system.

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**SYSTEM AND METHOD FOR AUTOMATED BIOMECHANICAL ANALYSIS
AND THE DETECTION AND CORRECTION OF POSTURAL DEVIATIONS**

The present invention relates to a system and method for the biomechanically accurate measurement of posture and for providing a patient with a suitable corrective exercise program. More particularly, the present invention relates to a system and method to automatically analyse the location of anatomical markers placed over skeletal landmarks to obtain biomechanical parameters; a system and method that uses these biomechanical data to automatically detect and/or quantify postural deviations from correct anatomical alignment; a system and method to automatically generate corrective exercise routines. The present invention also relates to the use of the Internet to provide a distributed system for patient care involving image acquisition in a clinical environment, data analysis at a central server and communication between the central server and the health-care professional as well as potential follow-up and feedback between the patient and either the health-care professional or the central server or both.

BACKGROUND OF THE INVENTION**Description of Prior Art**

A tree trunk grows straight up and tree branches are symmetrical around this solid core to provide a "posture" to withstand the effects of wind and gravity. We too have an optimal posture that allows us to function most efficiently. As builders and architects use plum lines to arrange the walls and supporting structures of a home, we use plumb lines to define this ideal postural alignment. In correct posture, a plumb line dropped from your ear will go through your shoulder, the middle of your pelvis, the middle of your knee, and the front of your anklebone. Your head, trunk, pelvis and knees are "stacked" one on top of the other. Deviations from this positioning can have negative consequences to your health and well being, and correcting postural alignment can make a person look and feel better. Ideal or optimal posture minimizes energy expenditure and muscle work necessary to maintain deviant posture in the face of gravitational forces. As patients become more and more proactive in their choice or health care, they will certainly demand amelioration of their disordered posture. For example, lower back pain has often been attributed to abnormal postural relationships between body segments, and is frequently a cause of patient complaints to family care physicians.

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Typically, practitioners are content with a basic appreciation of a client's posture. Systematic biomechanical analyses are rarely performed because they are time intensive and require specialized equipment. Instead, only qualitative observations are often made. Specialists, such as Chiropractors and physiotherapists are sometimes trained to make postural assessments, often employing qualitative measures to assess posture and determine corrective measures. Practitioners may refer to these specialists, but again, the procedures are time and labor intensive and consequently, are expensive for the patient, who may or may not have insurance to cover these expenses. Further, qualified medical practitioners, such as family practice physicians, may want to perform such analyses but lack the specialized equipment or training to accurately assess posture based on observations alone. Consequently, a cost effective and highly automatic system is needed to assist practitioners in effective assessment and treatment of postural difficulties.

Another deficiency of the actual method to evaluate and correct patient's posture is the loss of control of the health-care practitioner in the treatment given to his or her patient when he or she refers the patient to a specialist such as chiropractor or physiotherapist. The patient has to take several appointments from several potential specialists. Furthermore, no health-care practitioner or specialist alone can benefit from experience with thousands of patients and be able to correlate biomechanical information from these patients with appropriate treatment and results obtained. There is neither a way to share experience in an efficient way between several health-care practitioners and/or specialists treating this many patients. There is also no way to provide a quantified follow-up of progress.

SUMMARY OF THE INVENTION

One aim of the present invention is to provide a process and apparatus to acquire biomechanical position data in selecting marker positions referenced with respect to the patient's skeletal anatomy by one of skin surface features having minimal variability from one patient to the next and skeletal features palpable from a skin surface of the patient and in attaching a scanable marker on the patient at each of the marker positions, these marker positions being used to calculate the positions of body segments.

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Another aim is to provide a method and apparatus to analyze these body segment positions to obtain body segment biomechanical parameters and deviations.

Another aim of the present invention is to provide a method and apparatus to use these biomechanical deviation values to determine postural deviations and
5 corrective exercises to rectify these deviations.

Another aim of the present invention is to use the Internet to provide a distributed system for patient care involving image acquisition in a clinical environment, data analysis at a central server and communication between the central server and the health-care professional as well as potential follow-up and feedback
10 between the patient and either the health-care professional or the central server or both.

In accordance with the present invention there is provided a method of acquiring biomechanical position data for use in postural analysis, this method comprising the steps of:

- 15 a) selecting a plurality of marker positions referenced with respect to an anatomy of a patient by one of:
- skin surface features having minimal variability from one patient to the next; and
 - skeletal features palpable from a skin surface of the patient;
- 20 b) attaching a scanable marker on the patient at each of the marker positions, the step of attaching including palpating the patient to define at least some of the marker positions;
- instructing the patient to stand relaxed and in normal posture; and
- c) scanning the markers on the patient to obtain position data for each of the marker positions.

25 The method in accordance with a preferred embodiment of the present invention, wherein the patient is scanned from a front, side and rear viewpoints.

The method in accordance with a preferred embodiment of the present invention, wherein the step of scanning comprises photographing the patient against a backdrop, the markers comprising contrasting visual markers, the backdrop including a
30 plurality of scale and orientation reference marker points.

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The method in accordance with a preferred embodiment of the present invention, wherein the markers comprise an adhesive layer for sticking to the patient.

The method in accordance with a preferred embodiment of the present invention, wherein the step of photographing comprises using a digital camera with a
5 flash to obtain digital images, the markers comprising retroreflective markers.

The method in accordance with a preferred embodiment of the present invention, wherein some of the markers are scanned from more than one of the viewpoints and comprise retroreflective spheres.

The method in accordance with a preferred embodiment of the present
10 invention, wherein the step of instructing the patient to stand relaxed and in normal posture comprises requesting the patient to walk in place prior to standing still.

The method in accordance with a preferred embodiment of the present invention, wherein the step of scanning comprises automatically recognizing the markers and the reference marker points in the digital images using a computer.

15 The method in accordance with a preferred embodiment of the present invention, wherein the computer comprises a user interface and, when the computer recognizes too many or too few of the markers, input is accepted via the user interface to remove or add, with reference to the digital images, the position coordinates of the markers which the computer incorrectly recognized or failed to recognize.

20

In accordance with the present invention, there is provided a method for calculating postural deviation values in a patient comprising the steps of:

a) obtaining position data identifying a position in space of body segments of the patient while standing relaxed and in normal posture, the body segments comprising
25 head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles;

b) obtaining height and weight data of the patient;

c) calculating vertical and horizontal plumb lines using the position data;

d) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb lines using the position data.

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The method in accordance with a preferred embodiment of the present invention, wherein the angle and distance of deviation values are referenced with respect to average or normal values.

The method in accordance with a preferred embodiment of the present invention, further comprising a step of calculating an effective weight or stress of at least one of the body segments using an estimated weight of the at least one body segment and the deviation values.

The method in accordance with a preferred embodiment of the present invention, wherein the deviation values are calculated for all of the body segments.

10 In accordance with the present invention there is provided a method of selecting exercises for improving tonicity and correcting posture in a patient, the method comprising the steps of:

a) obtaining biomechanical position data of the patient while standing relaxed and in normal posture, the position data indicative of postural problems requiring correction;

b) ranking the postural deviations by severity and priority;

c) correlating the position data with exercises for strengthening or stretching specific muscles or muscle groups to obtain ranking data for the exercises;

d) compiling an exercise program for the patient based on the ranking data.

20 The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises manually selecting exercises from a ranked list of exercises.

The method in accordance with a preferred embodiment of the present invention, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

The method in accordance with a preferred embodiment of the present invention, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the

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position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

The method in accordance with a preferred embodiment of the present invention, wherein the position data identifies a position in space of body segments of the patient, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles, and the step of correlating comprises:

- a) calculating vertical and horizontal plumb lines using the position data;
- b) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb lines using the position data;
- 10 c) comparing the deviation values to normal values for the at least some of the body segments to obtain deviation priority values;
- d) ranking the deviation priority values according to an order of severity or importance; and
- e) determining the ranking data based on an association of the exercises with
15 body segment deviations in accordance with the order of severity or importance.

The method in accordance with a preferred embodiment of the present invention, wherein the step of ranking the deviation priority values according to an order of severity or importance comprises manually selecting deviations to be corrected by the exercise program, the order of severity or importance reflecting those deviations
20 manually selected.

The method in accordance with a preferred embodiment of the present invention, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, and the exercise program comprising a series of the sets of exercises.

25 The method in accordance with a preferred embodiment of the present invention, wherein the exercise program is limited to a maximum number of exercises, the step of manually selecting deviations is automatically restricted when a maximum number of exercises corresponding to the selected deviations exceeds the maximum number for the exercise program.

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The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

10 The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

15 The method in accordance with a preferred embodiment of the present invention, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

20 The method in accordance with a preferred embodiment of the present invention, further comprising steps of:

a) obtaining, after completing of the exercise program, new biomechanical position data of the patient while standing relaxed and in normal posture;

b) evaluating an effectiveness of the exercises in the exercise program for correcting the postural problems; and

25 c) adjusting parameters used in the step of correlating for future patients based on the effectiveness evaluated in the previous step.

The method in accordance with a preferred embodiment of the present invention, wherein the exercise program is repeatedly varied until the effectiveness of the exercises is optimized.

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The method in accordance with a preferred embodiment of the present invention, wherein the steps of correlating, evaluating and adjusting are carried out using a centralized shared database of the parameters used in the step of correlating for a large number of patients.

5 The method in accordance with a preferred embodiment of the present invention, wherein the parameters include at least one of age and an activity level of the patient.

In accordance with the present invention there is provided a method of providing posture health care using a distributed system, the method comprising the steps of:

10

- a) obtaining personal data of a patient, the personal data including weight, height, gender and activity data of the patient, and obtaining posture anatomical reference position data of the patient at a biomechanical measurement station;
- b) processing the personal and position data using data stored in a remote
15 central database to obtain preliminary postural deviation assessment data;
- c) providing the preliminary postural deviation assessment data to one of a health-care practitioner and the patient;
- d) obtaining corrected postural deviation assessment data from one of the health-care practitioner and the patient; and
- 20 e) modifying the data stored in the central database using the corrected data.

The method in accordance with a preferred embodiment of the present invention, wherein the preliminary postural deviation assessment data comprises a ranked list of deviations and a preliminary selection of the deviations to be included in a therapeutic exercise program, and the corrected data comprises a corrected selection
25 of the deviations to be included in a therapeutic exercise program.

The method in accordance with a preferred embodiment of the present invention, wherein:

the preliminary postural deviation assessment data comprises a set of therapeutic exercises of an exercise program;

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the corrected data comprises new posture anatomical reference position data of the patient obtained after completion of the exercise program; and

step (e) comprises processing the new reference position data to determine an effectiveness of the therapeutic exercises in correcting postural deviations and
5 modifying accordingly the data stored in the central database.

The method in accordance with a preferred embodiment of the present invention, wherein:

step (a) comprises validating completeness of the reference position data at the biomechanical measurement station and transmitting the personal and position data to a
10 central server;

step (b) is carried out at the central server;

step (c) comprises transmitting the preliminary postural deviation assessment data from the central server to one of the health-care practitioner and the patient;

step (d) comprises transmitting the corrected data to the central server; and

15 step (e) is carried out by the central server.

The method in accordance with a preferred embodiment of the present invention, wherein the biomechanical measurement station includes a health-care practitioner client station in communication with the central server.

The method in accordance with a preferred embodiment of the present
20 invention, wherein the client station uses a web browser interface to communicate with the central server, the central server providing a secure connection to a biomechanical assessment report web document for the patient.

For the purpose of the present invention the following terms are defined below.

25 The term "anterior view" is intended to mean the view of the front of the body (with the person in anatomical position). The term "lateral view" is intended to mean the view of the patient from the side.

The term "posterior view" is intended to mean the view of the patient from behind.

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The term "body segment parameters" is intended to mean the spatial coordinates of body segments and key anatomical landmarks taken from the images from the lateral, anterior and posterior views.

The present invention provides a process and apparatus to acquire patient
5 images rapidly and accurately in a clinical environment, to extract body segment parameters from surface markers, a method for analysing these data to obtain biomechanical parameters and deviations, a method involving the use of these biomechanical parameters and deviations for the detection of postural deviations and the selection of corrective exercises, and the use of Internet to provide a distributed
10 system for patient care involving image acquisition in a clinical environment, data analysis at a central server and communication between the central server and the health-care professional as well as potential follow-up and feedback between the patient and either the health-care professional or the central server or both. The placement of markers based on a well established model of ideal postural alignment is crucial
15 because the placement of markers determines the relative deviation of body segments from vertical and horizontal "plumb" or ideal alignment. The current system uses the most widely used and respected anatomical definition of ideal postural alignment (Kendall, McCreary, & Provance, 1993). And, a sophisticated marker placement system has been designed to place surface markers on locations defining this alignment.
20 The importance of a correct definition of ideal posture is obvious when one is attempting to detect postural deviations. A further crucial difference between the earlier systems and the present invention is the use of scanning technology to automatically detect the location of reflective markers placed on the skin overlying skeletal landmarks. They can be placed directly on the skin because they are made
25 from a hypoallergenic material. Such marker placement is highly important, because it avoids the potential examiner error associated with the manual identification of presumed skeletal landmarks from video images. The current system automatically detects markers, and their locations are transmitted automatically through the web for the calculation of postural deviations. Further differences between earlier state of the
30 art and the current system includes the automatic generation of a personalized exercise plan based on individualized and automatic assessments of patients' biomechanical and postural status.

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As such, the biomechanical knowledge system radically changes the practice of biomechanical analysis by creating an objective and effective methodology that is simple to implement using complex yet innovative technology. We have developed a strong theoretical model of biomechanical function as well as innovative methods for data capture,
5 analysis and adapted exercise routines. Both theoretical and technological aspects of our system have been integrated into a coherent and operational system.

We have successfully linked a biomechanical assessment of potential postural deviations to the underlying muscular components giving rise to these deviations. We go further by suggesting specific muscular training routines to
10 ameliorate the underlying muscular and postural deviations. This unique theoretical and methodological link will be outlined in more detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred
15 embodiment thereof, and wherein:

Fig. 1: surface anatomical marker locations in the anterior view;

Fig. 2: marker positions in the lateral view;

Fig. 3: marker positions in the posterior view;

Fig. 4: the retroreflective marker sticker construction according to the
20 preferred embodiment;

Fig. 5: the retroreflective marker sphere and application sticker assembly according to the preferred embodiment;

Fig. 6: the position of the camera and calibration backdrop;

Fig. 7: the perspective of the subject relative to the wall and the camera, as
25 well as measures used for calculations;

Fig. 8: the flowchart describing the image acquisition and the obtention of the location of anatomical markers;

Fig. 9 shows the flowchart describing the process to generate an exercise schedule;

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Fig. 10: the flowchart describing the overall process of biomechanical assessment, postural deviation detection, exercise generation, feedback from health-care practitioner to patient and follow-up.

Fig. 11: the schema server-user;

5 Fig. 12: description of missing marker calculation;

Fig. 13: page of the Biomechanical Assessment Report (Biomechanical Assessment Report) with patient's image, deviations and biomechanical parameters;

Fig. 14: page from the Biomechanical Assessment Report with postural deviations and associated exercises and stretching;

10 Fig. 15: page from the Biomechanical Assessment Report with exercise schedule; and

Fig. 16: page from the Biomechanical Assessment Report with illustration and description of two of the many possible exercises of the exercise program

DETAILED DESCRIPTION OF THE INVENTION

15 In accordance with the present invention, there is provided a system and method using biomechanical analysis to generate a schedule of corrective exercises suitable for a patient's condition.

The present invention follows the established biomechanical and clinical principle that resting, standing posture is a composite state made up of the relative position of body segments (e.g., head, trunk, legs) in space and relative to gravity. This is known as static postural alignment. Posture can also be described in terms of muscular balance. Proper posture is the result of symmetrical muscular development and the appropriate interaction of flexor and extensor muscles in a way that suits a vertical stance.

25 The method described in the present application is based on hypotheses underlying muscular balance, such hypotheses being that:

- All alignment problems yield abnormal tension and constrain the skeleton, joints, ligaments and muscles.

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- The study of the relative position of linked body segments reveals muscles that are hyper- or hypo-contracted.
- Alignment and muscular balance are correlated for normal posture.
- Muscular imbalance promotes an increase in the distance of a body segment from correct vertical and horizontal alignment.
- Depending on the deviation, antagonist muscle groups must be strengthened or stretched to achieve correct muscular balance and postural change.

The inseparable qualities that are alignment and muscular balance are central components of correct body mechanics. A correct vertical stance is the result of a harmonious combination of joint and body segment positions, which in turn stem from an optimal ratio of agonist/antagonist muscles. The energy expenditure required by the muscles is minimal. Therefore, there is an optimal alignment of the body that must take into account all anatomical structures involved in maintaining this alignment. Further, alignment is maximal when the load-bearing structures are also positioned optimally relative to gravity. The sum of forces that act on anatomical structures are balanced if the body is correctly positioned. Daily activities and habits often transform the body from ideal postural alignment independently of disease or structural anomalies. This can have highly negative consequences on daily living, and particularly in terms of the energy necessary to maintain the disordered posture and overlying movements. It is therefore very important to identify and correct these postural deviations.

The following steps are involved in the postural assessment-postural deviation muscular identification-exercise process. These steps consists of:

- Comprehensive biomechanical analysis
- Identification of postural deviations and ranking by order of priority
- Specification of muscular factors underlying the postural deviations
- Personalised muscular stretching and exercises routines to ameliorate postural deviations that incorporates level of difficulty and order of priority of deviations

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- Assessment of client progress by follow-up Biomechanical Assessment Reports and
- Modification of exercise protocol, if necessary.

The marker construction according to the preferred embodiment is illustrated in Figs. 4 and 5. There are two types of markers, flat round disks 25 and spheres 30. The disks 25 and spheres 30 share the same diameter, namely about 2 cm. The spherical and flat markers are placed on the surface of a patient's body using hypoallergenic adhesive, the markers being placed over skeletal landmarks that define ideal postural alignment. The skeletal landmarks used in the present invention are landmarks which have been recommended by the teachings of Kendall et al. (1993) mentioned above. The adhesive layer 24 is provided on a release sheet 20 with a lift-off tab 24. The retroreflective disk 25 is already attached to the adhesive sheet 22 which has the same shape as the disk, except for the tab 24. Due to the double-sided adhesive sheet 22, the adhesive layer 21 is hypoallergenic and is used to contact the skin or the tight clothing of the patient 36, while the adhesive layer 23 allows the disk 25 to be held in place or peeled off. When the disk 25 is peeled off, the sheet 22 remains adhered to the patient surface 36, and exposes the layer 23. The sphere 30, having a truncated flat side is adhered to layer 23, and is thus applied to patient surface 36. The sphere 30 comprises a wooden core 32 which is dipped in a retroreflective paint (Axon Alert 1460, Axon Aerospace, Greenville, U.S.A.) which forms a coating 34.

The disk 25 is cut from stock sheet of retroreflective material made by 3M, namely 3929 Thermal Transfer Printable Retro-Reflective Label Stock and has a thickness of 3 mm. The double-sided adhesive sheet 22 is made by 3M, namely 1522, Double Coated Medical Tape. The adhesive layers 21 and 23 are hypoallergenic, pressure sensitive acrylate adhesive. The coating material 34 comprises 85% solids per weight and the fineness of grind is 200 mesh. The mixing and coating process is as follows. Surfaces to be paint are cleaned and lightly abraded before coating. The spheres are then dipped between 2 to 5 minutes and dried under normal drying conditions.

Four digital images are taken of the patient using camera 10 in order to provide a visual image of postural alignment for the patients and health-care

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professionals and for the automatic detection of body segment parameters. The camera 10 has a standard built-in flash 12 which is set to operate during image acquisition. The intense light from the flash is reflected by the markers 25 and 30 and the markers appear as bright small circles in the acquired images. The high contrast of the markers 25 and 30 with respect to the image of the patient facilitates later automatic recognition of the markers. The placement of markers in the anterior view is shown in Fig. 1. FA02 is a spherical marker placed on the glabella, FA03 is a spherical marker placed on the middle of the chin and overlying the mental protuberance, FA05 is a spherical marker placed on the right shoulder over the acromion, FA07 is a spherical marker placed on 10 the left shoulder over the acromion, FA06 is a marker placed on the jugular notch, FA08 is a marker placed over the umbilicus, FA09 is a spherical marker placed on the right anterosuperior iliac spine, FA11 is a marker placed on the left anterior superior iliac spine, FA12 is a marker placed on the right wrist over the styloid process of the radius, FA13 is a marker placed on the left wrist over the styloid process of the 15 radius, FA14 is a marker centered over the right patella, FA15 is a marker centered over the left patella, FA16 is a marker centered between the right medial and lateral malleoli, FA18 is a marker centered between the left medial and lateral malleoli, FA19 is a marker placed on the anterior aspect of the right distal phalanx of the great toe and FA20 is a marker placed on the anterior aspect of the left distal phalanx of the great toe.

20 The markers on the lateral view are placed as shown in Fig. 2. SD01 is a marker placed on the tragus of the right ear, SD02 is a spherical marker placed on the glabella, SD03 is a spherical marker placed on the middle of the chin, and overlying the mental protuberance, SD04 is a spherical marker placed on the right shoulder over the acromion, SD05 is a spherical marker placed over the right posterior superior iliac 25 spine, SD08 is a spherical marker placed on the right anterosuperior iliac spine, SD09 is a marker placed over the greater trochanter, SD10 is a marker placed on Gerdy's tubercle and SD11 is a marker placed on the transverse tarsal joint.

The markers on the posterior view are placed as shown in Fig. 3. FP03 is a marker placed over the spinous process of the seventh cervical vertebra, FP04 is a 30 spherical marker placed on the left shoulder over the acromion, FP05 is a spherical marker placed on the right shoulder over the acromion, FP06 is a marker placed over the spinous process of the fifth thoracic vertebra, FP07 is a marker placed over the left

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posterior superior iliac spine, FP08 is a spherical marker placed over the right posterior superior iliac spine, FP10 is a marker placed on the left wrist over the styloid process of the ulna, FP11 is a marker placed on the right wrist over the styloid process of the ulna, FP12 is a marker placed over the center of the left popliteal cavity, FP13 is a marker
5 placed over the center of the right popliteal cavity, FP14 is a marker centered over the left Achilles tendon at the level of the medial malleolus, FP16 is a marker centered over the right Achilles tendon at the level of the medial malleolus, FP17 is a marker centered over the calcaneus of the left foot and FP19 is a marker centered over the calcaneus of the right foot.

10 Precise position of the markers is essential for accurate biomechanical assessment and detection of postural deviations. For this, the patient must wear very tight workout clothes to avoid hiding the few landmarks that are potentially covered by clothing. Most markers are placed directly over the body surface. The health-care practitioner must palpate the patient to make sure that the markers are well positioned.

15 Shown in Fig. 6 is the position of the camera and calibration backdrop. Pictures are taken with a flash to use the retroreflective property of the markers and make them more apparent on the pictures. The first picture is taken from the lateral view with arms down. The second picture is also from the lateral view but with the proximal arm flexed at 90° to detect the position of markers potentially hidden with
20 the arm down. These values are eventually transferred to the more "natural" lateral image with the arm down. The third and fourth pictures are taken from the anterior and posterior views, respectively. The pictures are taken against a backdrop including a plurality of scale and orientation reference marker points facilitating body segment parameters calculation. Also the patient is instructed to stand in a relaxed and normal
25 posture. To help the patient to adopt the most natural body posture possible, the patient is asked to walk in place prior to standing still.

The digital images are stored on a flash memory card within the camera and then transferred to a card reader connected to a computer which in turn, is connected to the Internet. The health-care professional can then connects to the central processing
30 server (4) of Fig. 12 entering on the system web site. First step, the health-care practitioner has to identify client. If the client has his or her first evaluation, personal data (height, weight, gender, age, activity level, preferred unit of measurement) is

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entered. A client identification number is created to identify client data in the database but protect confidentiality. In the second step, the health-care professional starts the image scanning and biomechanical assessment process. The health-care practitioner selects each patient's images in the directory on the computer. The positions of the anatomical markers that define body segments are scanned and coordinates sent via the Internet to the central server for processing. To protect patient privacy, the images themselves are never sent via the Web, only the coordinates of the markers are transferred.

The digital location of the markers is supplied and the system receives the scan, validates it and sends back a validation message to the health-care practitioner. The health-care professional receives an error message if insufficient or excessive markers are apparent in the automatic scan. A manual function is provided to correct marker placements, if necessary, and the images are re-scanned. If it is determined that the marker position data obtained from the images is flawed, the health-care professional may again acquire the images, possibly after rechecking the marker positioning. As will be appreciated, when the imaging is complete, and after confirming that the marker positions have been validated, the tabs 24 of the adhesive sheets 22 for the markers 25 and 30 facilitate removal of the adhesive sheets from the clothing or skin 36 of the patient (see Fig. 5). Since a large number of markers need to be removed, saving time in their removal allows the patient to finish up quicker and change back into his or her clothes.

The next step is to update credit information, submit it to the system and confirm payment. The system sends back a validation message to the health-care practitioner to proceed.

Further to that step, biomechanical calculations are executed on the central server (4) of the Fig. 11.

The first step is the conversion of images from pixels to actual distances. To do so, the origin is redefined as follow:

$$x' = x - \frac{w}{2}$$

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$$y' = \frac{h}{2} - y$$

where w = image width

and h = image height

Then the image rotation is proceed as follow:

$$5 \quad dx = \left(\frac{C1x - C2x}{2} \right) + \left(\frac{C3x - C4x}{2} \right)$$

$$dy = \left(\frac{C1y - C2y}{2} \right) + \left(\frac{C3y - C4y}{2} \right)$$

$$x'' = x' \frac{dy}{d} - y' \frac{dx}{d}$$

$$y'' = y' \frac{dy}{d} - x' \frac{dx}{d}$$

$$\text{where } d = \sqrt{dx^2 + dy^2}$$

- 10 with C1, C2, C3 and C4 being calibration points from the backdrop.

With these calculations it is possible to get coordinate values of the position of anatomical markers relevant to plumb lines in millimetres (or inches with conversion). Shown in Fig. 7 is the perspective needed for this process.

D = Calibration dimension (mm)

- 15 c = distance of camera from the wall

s = distance of the subject from the wall

$$D' = D \left(1 - \frac{s}{c} \right)$$

$$x''' = \frac{D'}{d} \left(x'' + \frac{w}{2} \right)$$

$$y''' = \frac{D'}{d} \left(y'' + \frac{h}{2} \right)$$

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The calculation of $(1-s/c)$ is obtained with the following formulas : $\tan(\alpha) = \frac{dy}{s} = \frac{y}{c}$

$$dy = \frac{y \times s}{c}$$

$$Y' = Y - dy$$

$$y' = y \left(1 - \frac{s}{c} \right)$$

5 The same calculations may be made with respect to x and the distance d' can be calculated as :

$$d' = d \left(1 - \frac{s}{c} \right)$$

The calculations made, the coordinates of markers are determined and expressed relative to vertical and horizontal plumb lines. The missing markers
10 positioned in pelvic area are then calculated. Shown below are the equations used to determine marker coordinates and Fig. 12 displays the missing markers on the pelvis area. SD5, SD8, SV5 and SV8 represent the markers on the pelvic area. d is the segment relating SD5 and SD8 and b is the segment relating SD5 and SD9. The angle θ is the angle between the markers SD5 and SD8. In reconstructing a right-angle
15 triangle where d is the hypotenuse, w is the leg facing the hypotenuse and h is the remaining leg of the rectangle.

Plus: FA9 ($x2''$, $y2''$) and FP9 ($x1''$, $y1''$)

$$dx = (x2' - x1')$$

$$bx = (x3' - x1')$$

$$20 \quad dy = (y2' - y1')$$

$$by = (y3' - y1')$$

$$h = (y2'' - y1'')$$

$$d = \sqrt{dx^2 + dy^2}$$

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$$b = \sqrt{bx^2 + by^2}$$

$$\vec{d} \cdot \vec{b} = db \cos \theta = dxbx + dyby$$

$$\theta = \cos^{-1} \left(\frac{dxbx + dyby}{db} \right)$$

$$d^2 = (x2 - x1)^2 + h^2$$

$$5 \quad x2 = x1 + \sqrt{d^2 - h^2} \quad \text{or} \quad x1 = x2 - \sqrt{d^2 - h^2}$$

$$y2 = y1 + h \quad \text{or} \quad y1 = y2 - h$$

$$w = x2 - x1$$

$$x3 = x1 + \frac{b}{d} (w \cos \theta - h \sin \theta)$$

$$y3 = y1 + \frac{b}{d} (h \cos \theta + w \sin \theta)$$

10

Marker coordinates are used in the next step to determine a patient's deviations from optimal alignment. Shown in Table 1 are the calculations necessary to determine postural deviations.

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Table 1

Code	Related body parts	Formula	Units
FA_ANG1	Shoulders	$\text{ARCTAN}((\text{FA07Y}-\text{FA05Y})/(\text{FA07X}-\text{FA05X}))$	°
FA_ANG2	Pelvis	$\text{ARCTAN}((\text{FA11Y}-\text{FA09Y})/(\text{FA11X}-\text{FA09X}))$	°
FA_ANG3	Knees	$\text{ARCTAN}((\text{FA15Y}-\text{FA14Y})/(\text{FA15X}-\text{FA14X}))$	°
FA_DIST1	Shoulders	$((\text{FA05X}+\text{FA07X})/2)-\text{FA17X}$	mm
FA_DIST2	Forehead	$\text{FA02X}-\text{FA17X}$	mm
FA_DIST3	Navel	$\text{FA08X}-\text{FA17X}$	mm
FA_DIST4	Pelvis	$\text{FA10X}-\text{FA17X}$	mm
FA_DIST5	Knees	$((\text{FA14X}+\text{FA15X})/2)-\text{FA17X}$	mm
FA_DIST6	Toes	$((\text{FA20X}+\text{FA19X})/2)-\text{FA17X}$	mm
FP_ANG_AN1	Left Foot	$\text{ARCTAN}((\text{FP14X}-\text{FP17X})/(\text{FP14Y}-\text{FP17Y}))$	°
FP_ANG_AN2	Right foot	$\text{ARCTAN}((\text{FP16X}-\text{FP19X})/(\text{FP16Y}-\text{FP19Y}))$	°
FP_ANG1	Shoulders	$\text{ARCTAN}((\text{FP05Y}-\text{FP04Y})/(\text{FP05X}-\text{FP04X}))$	°
FP_ANG2	Pelvis	$\text{ARCTAN}((\text{FP09Y}-\text{FP07Y})/(\text{FP09X}-\text{FP07X}))$	°
FP_ANG3	Knees	$\text{ARCTAN}((\text{FP13Y}-\text{FP12Y})/(\text{FP13X}-\text{FP12X}))$	°
FP_DIST1	Shoulders	$((\text{FP04X}+\text{FP05X})/2)-\text{FP18X}$	mm
FP_DIST2	7 th cervical	$\text{FP03X}-\text{FP18X}$	mm
FP_DIST3	5 th dorsal	$\text{FP06X}-\text{FP18X}$	mm
FP_DIST4	Pelvis	$\text{FP08X}-\text{FP18X}$	mm
FP_DIST5	Knees	$((\text{FP13X}+\text{FP12X})/2)-\text{FP18X}$	mm
FP_DIST6	Ankles	$\text{FP15X}-\text{FP18X}$	mm
SD_ANG1	Head-Shoulders	$\text{ARCTAN}((\text{SD01X}-\text{SD04X})/(\text{SD04Y}-\text{SD01Y}))$	°
SD_ANG2	Shoulders-Pelvis	$\text{ARCTAN}((\text{SD04X}-\text{SD07X})/(\text{SD07Y}-\text{SD04Y}))$	°

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Code	Related body parts	Formula	Units
SD_ANG3	Pelvis-Hips	$\text{ARCTAN}((\text{SD07X}-\text{SD09X}) / (\text{SD09Y}-\text{SD07Y}))$	°
SD_ANG4	Hips-Knees	$\text{ARCTAN}((\text{SD10X}-\text{SD09X}) / (\text{SD09Y}-\text{SD10Y}))$	°
SD_ANG5	Knees-Ankles	$\text{ARCTAN}((\text{SD11X}-\text{SD10X}) / (\text{SD10Y}-\text{SD11Y}))$	°
SD_DIST1	Head	$\text{SD01X}-\text{SD11X}$	mm
SD_DIST2	Shoulders	$\text{SD04X}-\text{SD11X}$	mm
SD_DIST3	Pelvis	$\text{SD07X}-\text{SD11X}$	mm
SD_DIST4	Hips	$\text{SD09X}-\text{SD11X}$	mm
SD_DIST5	Knees	$\text{SD10X}-\text{SD11X}$	mm

Deviations from horizontal and vertical alignment, moments of force and reaction forces, and center of gravity are calculated from the biomechanical parameters obtained from the images in the lateral, anterior and posterior views. The deviation values are referenced with respect to body alignment position values. These values are used both in the detection of postural deviations and also as a follow-up tool to assess patient progress after following a corrective exercise plan.

These values are used as a diagnostic tool and as a way to measure progress in the patient's condition.

10 Constants:

Head Ratio: $RaH = 8.4\%$

Trunk Ratio: $RaT = 58.4\%$

Gravity: $G = 9.8 \text{ m/s}^2$

Global:

15 Weight Total: $We = \text{Total person mass (kg)}$

Weight head: $WeH = We * RaH * G$

Weight trunk: $WeT = We * RaT * G$

Weight head&trunk: $WeHT = WeH + WeT$

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Lateral Plane:

$$\text{Angle Head: } LAnHA = ATan\left(\frac{SD01X - SD04X}{SD04Y - SD01Y}\right)$$

$$\text{Moment Head: } LMoH = \frac{WeH * (SD01X - SD04X)}{1000}$$

$$\text{Reaction Head: } LReH = -LMoH * 25 - WeH$$

$$5 \quad \text{Reaction Head \%: } Abs\left(\frac{LReH}{WeH}\right)$$

$$\text{Angle Trunk: } LAnTI = ATan\left(\frac{SD04X - SD07X}{SD07Y - SD04Y}\right)$$

$$\text{Moment Trunk: } LMoT = \frac{WeT * (SD04X - SD07X)}{1000}$$

$$\text{Reaction Trunk: } LReT = -LMoT * 20 - WeHT$$

$$\text{Reaction Trunk \%: } LReTP = Abs\left(\frac{LReT}{WeT}\right)$$

$$10 \quad \text{Angle Head\&Trunk: } LAnHA = ATan\left(\frac{SD01X - SD07X}{SD07Y - SD01Y}\right)$$

$$\text{Moment Head\&Trunk: } LMoHT = \frac{WeHT * (SD01X - SD07X)}{1000}$$

$$\text{Reaction Head\&Trunk: } LReH = -LMoHT * 20 - WeHT$$

$$\text{Reaction Head\&Trunk \%: } LReHTP = Abs\left(\frac{LReHT}{WeHT}\right)$$

Front Plane:

$$15 \quad \text{Angle Head: } LAnHA = ATan\left(\frac{FA02X - FA06X}{FA06Y - FA02Y}\right)$$

$$\text{Moment Head: } LMoH = \frac{WeH * (FA06X - FA02X)}{1000}$$

$$\text{Reaction Head: } LReH = -LMoH * 25 - WeH$$

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$$\text{Reaction Head \% : } Abs\left(\frac{LReH}{WeH}\right)$$

$$\text{Angle Trunk: } LAnTI = ATan\left(\frac{FA06X - FA10X}{FA10Y - FA06Y}\right)$$

$$\text{Moment Trunk: } LMoT = \frac{WeH * (FA10X - FA06)}{1000}$$

$$\text{Reaction Trunk: } LReT = -LMoT * 20 - WeT$$

$$5 \quad \text{Reaction Trunk \% : } LReTP = Abs\left(\frac{LReT}{WeT}\right)$$

$$\text{Angle Head and Trunk: } LAnHTI = ATan\left(\frac{FA02X - FA10X}{FA10Y - FA02Y}\right)$$

$$\text{Moment Head and Trunk: } LMoHT = \frac{WeHT * (FA10X - FA02X)}{1000}$$

$$\text{Reaction Head and Trunk: } LReHT = -LMoHT * 20 - WeHT$$

$$\text{Reaction Head and Trunk \% : } Abs\left(\frac{LReHT}{WeHT}\right)$$

10 The center of gravity projection is calculated as follows:

$$\begin{aligned} \text{X coordinates: } & ((FA17X - (FA02X + FA04X) / 2) * WeFAH + (FA17X - \\ & (FA07X + FA05X) / 2) * WeFAS + (FA17X - \\ & (FA11X + FA09X) / 2) * WeFAP + (FA17X - \\ & (FA14X + FA15X) / 2) * WeFAK) / (WeFAH + WeFAS + WeFAP + WeFAK) \end{aligned}$$

15 Y coordinates: $((SD11X - SD01X) * WeSDH + (SD11X - SD04X) * WeSDS + (SD11X - SD07X) * WeSDP + (SD09X - SD10X) / \sqrt{(SD10Y - SD09Y)^2 + (SD09X - SD10X)^2} * \text{RATIO_SD_THIGH_LENGTH} * \text{Height} * WeSDT + (SD10X - SD11X) / \sqrt{(SD11Y - SD10Y)^2 + (SD10X - SD11X)^2} * \text{RATIO_SD_LEG_LENGTH} * \text{Height} * WeSDK) / (WeSDH + WeSDS + WeSDP + WeSDT + WeSDK)$

20

Where the parameters used to calculate the center of gravity are described herewith:

Parameters	Description	View
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Parameters	Description	View
WeFAH	Head weight	Anterior
WeFAS	Shoulder weight	Anterior
WeFAP	Pelvis weight	Anterior
WeFAK	Segment weight (whole leg)	Anterior
WeSDH	Head weight	Lateral
WeSDS	Shoulder weight	Lateral
WeSDP	Pelvis weight	Lateral
WeSDT	Thigh weight	Lateral
WeSDK	Segment weight (knee to foot)	Lateral
Ratio_SD_Thigh_Length	Center of mass for the thigh in % of the segment length	Lateral
Ratio_SD_Leg_Length	Center of mass for the leg (knee to foot) in % of the segment length	Lateral

These coordinates are then compared to the ideal center of gravity position located on the base of support between the feet.

When the Biomechanical Assessment is complete (a virtual instantaneous process through the central server), data are transferred back to the health-care practitioner's computer via the Web. A Biomechanical Assessment Report can then be generated and modified as needed. The health-care practitioner has the possibility to adjust postural deviations based on supplemental information that he or she may have noted during the patient's examination. Postural deviations are ranked automatically and based on the relative importance of the trunk and head and neck stability on postural function. The top three deviations are selected by default for the treatment, but the health-care practitioner has the possibility to select other deviations. Every change made by the health-care practitioner is identified in the system to take it into account during further statistical analysis. When the deviations selected for the treatment are

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confirmed correctives exercises are automatically generated. A ten-week exercise schedule is generated which is, again, modifiable by the health-care practitioner if necessary. Exercises are selected compatible with a patient's activity level from low, to moderately to highly active. The health-care practitioner also has the opportunity to

5 change exercise selection and/or schedule. The health-care practitioner can ask the system to increase or decrease the difficulty level of the program and generate a new schedule based on the request. The health-care practitioner can also remove or add exercises from the program because he or she thinks that a particular exercise can be

10 harmful to the patient or to place emphasis on a particular deviation correction. Finally, health-care practitioner can reorganize the schedule in changing the order of exercises. Presented in Tables 2 and 3 are lists of deviations that are detectable by the current system, as well as the corrective actions by exercising and stretching to correct these deviations.

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Table 2

Deviations - Exercises link

<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
<i>DIS001</i>	Translation of the head to the left		
	<i>NHLF_LS</i>		
		NHLRO19SR Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHL01 1SR Neck lateral flexor stretch	*
		NHLO17SR Assisted neck lateral flexor stretch	2,3
		NHLO24SR Supine neck lateral flexor stretch	1
		NHLRO14SL Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SR Neck extensor, lateral flexor and rotator stretch	1
		NHLRO18SR Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLRO20SR Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHXL005SR Assisted neck flexor and lateral flexor stretch	2,3
		NHXLRO03SR Neck flexor, rotator and lateral flexor stretch	1
		NHXLRO07SR Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLRO08SR Assisted neck flexor, lateral flexor and rotator stretch	2,3
	<i>NHLF_RC</i>		
		NHLF010CR Cervical strengthening	1,2
		NHLF011CR Supine cervical strengthening	1
		NHLF012CR Cervical strengthening with elastic resistance	2,3
<i>DIS002</i>	Translation of the head to the right		
	<i>NHLF_LC</i>		
		NHLF010CL Cervical strengthening	1,2
		NHLF01 1CL Supine cervical strengthening	1
		NHLF012CL Cervical strengthening with elastic resistance	2,3
	<i>NHLF_RS</i>		
		NHLRO19SL Assisted neck extensor, lateral flexor and rotator	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		stretch	
		NHL01 1SL Neck lateral flexor stretch	*
		NHL017SL Assisted neck lateral flexor stretch	2,3
		NHL024SL Supine neck lateral flexor stretch	1
		NHLR014SR Neck flexor, lateral flexor and rotator stretch	1
		NHLR015SL Neck extensor, lateral flexor and rotator stretch	1

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<i>Deviation</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>s</i>			
		NHLR01 8SL	Assisted neck flexor, lateral flexor and rotator stretch 2,3
		NHLR020SL	Assisted neck extensor, lateral flexor and rotator stretch 2,3
		NHLR021SL	Neck lateral flexor stretch 2,3
		NHXL005SL	Assisted neck flexor and lateral flexor stretch 2,3
		NHXLRO03SL	Neck flexor, rotator and lateral flexor stretch 1
		NHXLRO07SL	Assisted neck flexor, lateral flexor and rotator stretch 2,3
		NHXLRO08SL	Assisted neck flexor, lateral flexor and rotator stretch 2,3
<i>DIS003</i>	Protrusion of the head		
	<i>NHEX.S</i>		
		NHF009SB	Neck extensor stretch *
	<i>NHFL.C</i>		
		NHFL001CB	Cervical strengthening 2
		NHFL002CB	Cervical strengthening *
		NHFL003CB	Supine cervical strengthening 2
		NHFL009CB	Cervical strengthening 2
	<i>TRCE.C</i>		
		TREX002CB	Prone trunk extension 2,3
		TREX007CB	Arm and hip extension 2,3
		TREX010CB	Prone lumbar extension with hands on the lower back *
		TREX011CB	Prone lumbar extension with hands behind your head 2,3
		TREX012CB	Seated lumbar extension 1
<i>DIS004</i>	Posterior deviation of the head		
	<i>NHEX.S</i>		
		NHF009SB	Neck extensor stretch *
	<i>NHFL.C</i>		
		NHFL001CB	Cervical strengthening 2
		NHFL002CB	Cervical strengthening *
		NHFL003CB	Supine cervical strengthening 2
		NHFL009CB	Cervical strengthening 2

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<i>Deviation</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>s</i>			
<i>NHFL.S</i>			
		NHEX001SB Neck flexor stretch	1
		NHXLRO04SB Assisted neck flexor stretch	2,3
<i>TRCE.S</i>			
		TREX004SB Standing torso flexion with arms reaching down	*

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		TREX009SB	Supine back extensor stretch propped up on your elbows 1
<i>DIS005</i>	Flexion of the head		
	<i>NHEX.C</i>		
		NHEX004CB	Cervical strengthening 1
		NHEX005CB	Cervical strengthening 1
		NHEX007CB	Cervical strengthening with elastic resistance 2,3
		NHEX008CB	Prone cervical strengthening 2
	<i>NHLF_L.S</i>		
		NHFLR019SR	Assisted neck extensor, lateral flexor and rotator stretch 2,3
		NHL01 1SR	Neck lateral flexor stretch *
		NHL017SR	Assisted neck lateral flexor stretch 2,3
		NHL024SR	Supine neck lateral flexor stretch 1
		NHLR014SL	Neck flexor, lateral flexor and rotator stretch 1
		NHLR015SR	Neck extensor, lateral flexor and rotator stretch 1
		NHLR01 8SR	Assisted neck flexor, lateral flexor and rotator stretch 2,3
		NHLR020SR	Assisted neck extensor, lateral flexor and rotator stretch 2,3
		NHXL005SR	Assisted neck flexor and lateral flexor stretch 2,3
		NHXL003SR	Neck flexor, rotator and lateral flexor stretch 1
		NHXL007SR	Assisted neck flexor, lateral flexor and rotator stretch 2,3
		NHXL008SR	Assisted neck flexor, lateral flexor and rotator stretch 2,3
	<i>NHLF_R.S</i>		
		NHFLR019SL	Assisted neck extensor, lateral flexor and rotator stretch 2,3
		NHL011SL	Neck lateral flexor stretch *
		NHL017SL	Assisted neck lateral flexor stretch 2,3
		NHL024SL	Supine neck lateral flexor stretch 1
		NHLR014SR	Neck flexor, lateral flexor and rotator stretch 1
		NHLR015SL	Neck extensor, lateral flexor and rotator stretch 1

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		NHLR018SL Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLR020SL Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHLR021SL Neck lateral flexor stretch	2,3
		NHXL005SL Assisted neck flexor and lateral flexor stretch	2,3
		NHXL003SL Neck flexor, rotator and lateral flexor stretch	1
		NHXL007SL Assisted neck flexor, lateral flexor and rotator stretch	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		NHXLRO08SL Assisted neck flexor, lateral flexor and rotator stretch	2,3
	<i>TRCE.C</i>		
		TREX002CB Prone trunk extension	2,3
		TREX007CB Arm and hip extension	2,3
		TREX010CB Prone lumbar extension with hands on the lower back	*
		TREX011CB Prone lumbar extension with hands behind your head	2,3
		TREX012CB Seated lumbar extension	1
<i>DIS006</i>	Extension of the head		
	<i>NHEX.S</i>		
		NHF009SB Neck extensor stretch	*
	<i>NHFL.C</i>		
		NHFL001CB Cervical strengthening	2
		NHFLO02CB Cervical strengthening	*
		NHFLO03CB Supine cervical strengthening	2
		NHFLO09CB Cervical strengthening	2
	<i>SCAD.S</i>		
		SCAD001SB Scapula adductor stretch with your hands behind your back	*
		SCAD007SB Scapula adductor stretch with your arms crossed	1
<i>DIS009</i>	Lateral flexion of the head to the right		
	<i>NHLF_L.C</i>		
		NHLF010CL Cervical strengthening	1,2
		NHLF011CL Supine cervical strengthening	1
		NHLF012CL Cervical strengthening with elastic resistance	2,3
	<i>NHLF_RS</i>		
		NHFLRO19SL Assisted neck extensor, lateral flexor and rotator stretch	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		NHLO1 1SL Neck lateral flexor stretch	*
		NHLO17SL Assisted neck lateral flexor stretch	2,3
		NHLO24SL Supine neck lateral flexor stretch	1
		NHLRO14SR Neck flexor, lateral flexor and rotator stretch	1
		NHLRO15SL Neck extensor, lateral flexor and rotator stretch	1
		NHLRO18SL Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLRO20SL Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHLRO21SL Neck lateral flexor stretch	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		NHXL005SL Assisted neck flexor and lateral flexor stretch	2,3
		NHXLRO03SL Neck flexor, rotator and lateral flexor stretch	1
		NHXLRO07SL Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLRO08SL Assisted neck flexor, lateral flexor and rotator stretch	2,3
<i>DIS010</i>	Lateral flexion of the head to the left <i>NHLF_L.S</i>		
		NHFLR019SR Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHL01 1SR Neck lateral flexor stretch	*
		NHLO17SR Assisted neck lateral flexor stretch	2,3
		NHLO24SR Supine neck lateral flexor stretch	1
		NHLR014SL Neck flexor, lateral flexor and rotator stretch	1
		NHLR015SR Neck extensor, lateral flexor and rotator stretch	1
		NHLR018SR Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHLR020SR Assisted neck extensor, lateral flexor and rotator stretch	2,3
		NHXL005SR Assisted neck flexor and lateral flexor stretch	2,3
		NHXLRO03SR Neck flexor, rotator and lateral flexor stretch	1
		NHXLRO07SR Assisted neck flexor, lateral flexor and rotator stretch	2,3
		NHXLRO08SR Assisted neck flexor, lateral flexor and rotator stretch	2,3
	<i>NHLF_R.C</i>		
		NHLF010CR Cervical strengthening	1,2
		NHLF01 1CR Supine cervical strengthening	1
		NHLF012CR Cervical strengthening with elastic resistance	2,3
<i>DIS011</i>	Lateral translation of the trunk to the left <i>TRLF_L.C</i>		
		TRFL015CL Isometric abdominal contraction with leg extension	1
		TRLF001CL Lateral flexion with a dumbbell	2,3
		TRLF002CL Lateral flexion with a dumbbell	2,3
		TRLF003CL Lateral flexion with a bar	2,3
		TRLF004CL Lateral flexion with a bar	1

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		TRLF005CL Lateral flexion with elastic resistance	*
		TRLF008CL Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CL Inclined lateral flexion with crossed arms, holding a weight	3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		<i>TRLF_R.S</i>	
		TRLF001SR Standing lateral trunk flexor stretch	*
		<i>TRTE_R.S</i>	
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX009SB Supine back extensor stretch propped up on your elbows	1
<i>DIS012</i>	Lateral translation of the trunk to the right		
		<i>TRLF_L.S</i>	
		TRLF001SL Standing lateral trunk flexor stretch	*
		<i>TRLF_R.C</i>	
		TRFL015CR Isometric abdominal contraction with leg extension	1
		TRLF001 CR Lateral flexion with a dumbbell	2,3
		TRLF002CR Lateral flexion with a dumbbell	2,3
		TRLF003CR Lateral flexion with a bar	2,3
		TRLF004CR Lateral flexion with a bar	1
		TRLF005CR Lateral flexion with elastic resistance	*
		TRLF008CR Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CR Inclined lateral flexion with crossed arms, holding a weight	3
		<i>TRTE_L.S</i>	
		TREX001SB Cat stretch	*
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX009SB Supine back extensor stretch propped up on your elbows	1
<i>DIS013</i>	Anterior deviation		

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		<i>HIEX.S</i>	
		HIEX012SB Seated bilateral hamstring stretch	*
		HIEX013SB Seated bilateral hamstring stretch	3
		<i>HIFL.L.S</i>	
		HIFL001SL Standing hip flexor stretch	2,3
		HIFL002SL Standing hip flexor stretch (partial)	1
		HIFL003SL Standing hip flexor stretch with back leg elevated	3
		<i>HIFL.R.S</i>	
		HIFL001SR Standing hip flexor stretch	2,3
		HIFL002SR Standing hip flexor stretch (partial)	1

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		HIFLO03SR Standing hip flexor stretch with back leg elevated	3
		<i>SCAD.C</i>	
		SCAD001 CB Shoulder shrugs with dumbbells held in semi-supination while inclined	3
		SCAD002CB Shoulder shrugs with dumbbells held in pronation while inclined	3
		SCAD003CB Seated scapular adduction	*
		<i>SHAD.S</i>	
		SHAD001 SB Shoulder adductor stretch	*
		<i>TRLE.C</i>	
		TREX001 CB Kneeling trunk extension	2,3
		TREX002CB Prone trunk extension	2,3
		TREX007CB Arm and hip extension	2,3
		TREX010CB Prone lumbar extension with hands on the lower back	*
		TREX011CB Prone lumbar extension with hands behind your head	2,3
		TREX012CB Seated lumbar extension	1
<i>DIS014</i>	Posterior deviation	<i>HIFL.L.S</i>	
		HIFLO01SL Standing hip flexor stretch	2,3
		HIFLO02SL Standing hip flexor stretch (partial)	1
		HIFLO03SL Standing hip flexor stretch with back leg elevated	3
		<i>HIFL.R.S</i>	
		HIFLO01SR Standing hip flexor stretch	2,3
		HIFLO02SR Standing hip flexor stretch (partial)	1
		HIFLO03SR Standing hip flexor stretch with back leg elevated	3
		<i>SCAD.S</i>	
		SCAD001 SIB Scapula adductor stretch with your hands behind your back	*
		SCAD007SB Scapula adductor stretch with your arms crossed	1

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>TRFL.C</i>			
		TRFL001CB Abdominal crunch with feet elevated	1
		TRFL002CB Abdominal crunch with feet on the ground	1
		TRFL003CB Abdominal crunch with feet on the ground and lumbar support	1
		TRFL004CB Abdominal crunch with arms crossed and feet elevated	1,2
		TRFL005CB Abdominal crunch with hands behind the head and feet elevated	2

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		TRFLO06CB Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFLO07CB Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFLO08CB Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO09CB Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO12CB Hip raises (lower abdominal crunch)	3
		TRFLO13CB Abdominal crunch with arms extended at the elbows, pointing forward	2,3
		TRFLO14CB Isometric abdominal contraction	1
	<i>TRLE.S</i>		
		TREX001 SB Cat stretch	*
		TREX002SB Supine, knees to chest	1,2
		TREX003SB Standing torso flexion	1,2
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX006SB Seated trunk flexion	1
		TREX008SB Seated full forward stretch	1,2
	<i>TRTE.S</i>		
		TREX001 SB Cat stretch	*
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX009SB Supine back extensor stretch propped up on your elbows	1
<i>DIS015</i>	Trunk flexion		
	<i>HIEX.S</i>		
		HIEX012SB Seated bilateral hamstring stretch	*
		HIEX013SB Seated bilateral hamstring stretch	3
	<i>HIFL_L.S</i>		
		HIFLO01SL Standing hip flexor stretch	2,3
		HIFLO02SL Standing hip flexor stretch (partial)	1

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		HIFLO03SL Standing hip flexor stretch with back leg elevated	3
	<i>HIFL_R</i>		
	<i>S</i>		
		HIFLO01SR Standing hip flexor stretch	2,3
		HIFLO02SR Standing hip flexor stretch (partial)	1
		HIFLO03SR Standing hip flexor stretch with back leg elevated	3
	<i>NHEX.S</i>		
		NHF009SB Neck extensor stretch	*

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		<i>SHAD.S</i>	
		SHAD001SB Shoulder adductor stretch	*
		<i>TRLE.C</i>	
		TREX001CB Kneeling trunk extension	2,3
		TREX002CB Prone trunk extension	2,3
		TREX007CB Arm and hip extension	2,3
		TREX010CB Prone lumbar extension with hands on the lower back	*
		TREX011CB Prone lumbar extension with hands behind your head	2,3
		TREX012CB Seated lumbar extension	1
		<i>TRTE.C</i>	
		TREX001 CB Kneeling trunk extension	2,3
		TREX002CB Prone trunk extension	2,3
		TREX007CB Arm and hip extension	2,3
		TREX010CB Prone lumbar extension with hands on the lower back	*
		TREX011CB Prone lumbar extension with hands behind your head	2,3
		TREX012CB Seated lumbar extension	1
<i>DIS016</i>	Trunk extension		
		<i>NHEX_L</i>	
		<i>.S</i>	
		NHF009SB Neck extensor stretch	*
		NHFR010SL Assisted neck extensor, lateral flexor and rotator stretch	*
		<i>NHEX_R</i>	
		<i>.S</i>	
		NHF009SB Neck extensor stretch	*
		NHFR010SR Assisted neck extensor, lateral flexor and rotator stretch	*
		<i>SCAB.C</i>	
		SCAB001CB Abdominal crunch with hands behind the head and feet on the floor	*
		<i>SCAD.S</i>	

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		SCAD001SB Scapula adductor stretch with your hands behind your back	*
		SCAD007SB Scapula adductor stretch with your arms crossed	1
	TRLF_L. S	TRLF001SL Standing lateral trunk flexor stretch	*
	TRLF_R. S	TRLF001 SR Standing lateral trunk flexor stretch	*

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		<i>TRTE.S</i>	
		TREX001SB Cat stretch	*
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX009SB Supine back extensor stretch propped up on your elbows	1
<i>DIS019</i>	Lateral flexion of the trunk to the right		
	<i>TRLF_L.C</i>		
		TRFL015CL Isometric abdominal contraction with leg extension	1
		TRLF001CL Lateral flexion with a dumbbell	2,3
		TRLF002CL Lateral flexion with a dumbbell	2,3
		TRLF003CL Lateral flexion with a bar	2,3
		TRLF004CL Lateral flexion with a bar	1
		TRLF005CL Lateral flexion with elastic resistance	*
		TRLF008CL Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CL Inclined lateral flexion with crossed arms, holding a weight	3
	<i>TRLF_R.S</i>		
		TRLF001 SR Standing lateral trunk flexor stretch	*
<i>DIS020</i>	Lateral flexion of the trunk to the left		
	<i>TRLF_L.S</i>		
		TRLF001SL Standing lateral trunk flexor stretch	*
	<i>TRLF_R.C</i>		
		TRFL015CR Isometric abdominal contraction with leg extension	1
		TRLF001 CR Lateral flexion with a dumbbell	2,3
		TRLF002CR Lateral flexion with a dumbbell	2,3
		TRLF003CR Lateral flexion with a bar	2,3
		TRLF004CR Lateral flexion with a bar	1
		TRLF005CR Lateral flexion with elastic resistance	
		TRLF008CR Lateral flexion on an incline bench with arms across	1,2

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		the chest	
		TRLF009CR Inclined lateral flexion with crossed arms, holding a weight	3
DIS021	Translation of the hip to the left		
	HLAB_L.C		
		HIAB001CL Side lying hip abductor contraction	1

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		HIAB002CL Side lying hip abductor contraction	1
		HIAB003CB Bilateral hip abductor contraction	2,3
		HIAB004CL Unilateral hip abduction exercise	1,2
		HIAB005CL Supine, anterior, unilateral hip abduction exercise with an elastic	2,3
		HIAB006CL Side lying hip abductor contraction with dumbbells	2,3
		HIAB007CL Side lying hip abductor contraction with elastic resistance	2,3
		HIAB008CL Side lying hip abductor contraction with added weight	*
		HIAB011 CL Standing unilateral hip abduction exercise	2,3
		HIAB012CL Standing, anterior, unilateral hip abduction exercise	2,3
		HIAB013CL Standing, posterior, unilateral hip abduction exercise	2,3
	<i>HIAB_</i>		
	<i>RS</i>		
		HIAB001SR Side lying hip abductor stretch	1,2,3
		HIAB005SR Standing hip abductor stretch	2,3
		HIAB006SR Standing hip abductor stretch with lateral flexion	2,3
		HIAB007SR Standing hip abductor stretch with lateral flexion	*
	<i>HIAD_</i>		
	<i>LS</i>		
		HIAD005SL Standing hip adductor stretch	*
		HIAD008SL Kneeling hip adductor stretch	3
	<i>HIAD_</i>		
	<i>RC</i>		
		HIAD001CR Side lying isometric hip adduction	*
		HIAD002CR Supine hip adduction with elastic resistance	2,3
		HIAD003CR Side lying hip adduction	2,3
		HIAD006CB Supine hip adduction with a ball between the knees	1,2
		HIAD010CB Supine hip adduction with a ball between the knees	1,2
		HIAD011CR Side lying hip adduction with a ball placed between your feet	1,2
		HIAD012CR Side lying hip adduction with a ball between the knees and thighs	1,2

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>DIS022</i>	Translation of the	hip to the right	
	<i>HLAB</i>		
	<i>L.S</i>		
		HIAB001SL Side lying hip abductor stretch	1,2,3
		HIAB005SL Standing hip abductor stretch	2,3
		HIAB006SL Standing hip abductor stretch with lateral flexion	2,3
		HIAB007SL Standing hip abductor stretch with lateral flexion	*
	<i>HLAB</i>		
	<i>R.C</i>		

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<i>Deviations Actions</i>	<i>Exercises</i>	<i>Levels</i>
	HIAB001CR Side lying hip abductor contraction	1
	HIAB002CR Side lying hip abductor contraction	*
	HIAB003CB Bilateral hip abductor contraction	2,3
	HIAB004CR Unilateral hip abductor exercise	1,2
	HIAB005CR Supine, anterior, unilateral hip abduction exercise with an elastic	2,3
	HIAB006CR Side lying hip abductor contraction with dumbbells	2,3
	HIAB007CR Side lying hip abductor contraction with elastic resistance	2,3
	HIAB008CR Side lying hip abductor contraction with added weight	3
	HIAB011 CR Standing unilateral hip abduction exercise	2,3
	HIAB012CR Standing, anterior, unilateral hip abduction exercise	2,3
	HIAB013CR Standing, posterior, unilateral hip abduction exercise	2,3
<i>HIAD_L.C</i>		
	HIAD001CL Side lying isometric hip adduction	1
	HIAD002CL Supine hip adduction with elastic resistance	2,3
	HIAD003CL Side lying hip adduction	2,3
	HIAD006CB Supine hip adduction with a ball between the knees	1,2
	HIAD010CB Supine hip adduction with a ball between the knees	1,2
	HIAD011CL Side lying hip adduction with a ball placed between your feet	1,2
	HIAD012CL Side lying hip adduction with a ball between the knees and thighs	1,2
<i>HIAD_R.S</i>		
	HIAD005SR Standing hip adductor stretch	*
	HIAD008SR Kneeling hip adductor stretch	3
<i>DIS023</i> Anterior translation of the hip		
<i>HIEX.C</i>		
	HIEX001CB Supine pelvic tilt	*
<i>HIFL_L.S</i>		
	HIFL001SL Standing hip flexor stretch	2,3
	HIFL002SL Standing hip flexor stretch (partial)	1

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<i>Deviations Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>HIFL_RS</i>	HIFLO03SL Standing hip flexor stretch with back leg elevated	3
	HIFLO01SR Standing hip flexor stretch	2,3
	HIFLO02SR Standing hip flexor stretch (partial)	1
	HIFLO03SR Standing hip flexor stretch with back leg elevated	3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>DIS024</i>	Posterior translation of the hip		
	<i>HIEX_L.S</i>		
		HIEX001SL Standing hamstring stretch	*
		HIEX002SL Supine hamstring stretch	2,3
		HIEX003SL Supine hamstring stretch	1
		HIEX004SL Supine hamstring stretch	1
		HIEX007SL Supine hamstring stretch	1
		HIEX008SL Supine hamstring stretch	2,3
		HIEX011SL Seated hamstring stretch	2,3
		HIEX012SB Seated bilateral hamstring stretch	*
		HIEX013SB Seated bilateral hamstring stretch	3
		HIEX014SL Standing hamstring stretch	2,3
	<i>HIEX_R.S</i>		
		HIEX001SR Standing hamstring stretch	*
		HIEX002SR Supine hamstring stretch	2,3
		HIEX003SR Supine hamstring stretch	1
		HIEX004SR Supine hamstring stretch	1
		HIEX007SR Supine hamstring stretch	1
		HIEX008SR Supine hamstring stretch	2,3
		HIEX011SR Seated hamstring stretch	2,3
		HIEX012SB Seated bilateral hamstring stretch	*
		HIEX013SB Seated bilateral hamstring stretch	3
		HIEX014SR Standing hamstring stretch	2,3
	<i>HIFL_L.C</i>		
		HIFL001CB Squat	*
		HIFL002CB Unilateral squat	*
		TRFL010CL Abdominal crunch with unilateral hip flexion	2,3
		TRFL011CL Abdominal crunch with arms overhead and unilateral hip flexion	2,3
		TRFL012CB Hip raises (lower abdominal crunch)	3
	<i>HIFL_R.C</i>		

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		HIFLO01CB Squat	*
		HIFLO02CB Unilateral squat	*
		TRFLO10CR Abdominal crunch with unilateral hip flexion	2,3
		TRFLO11CR Abdominal crunch with arms overhead and feet elevated	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		TRFL012CB Hip raises (lower abdominal crunch)	3
<i>DIS025</i>	Anterior pelvic tilt		
	<i>HIEX.C</i>		
		HIEX001CB Supine pelvic tilt	*
	<i>HIEX.L.S</i>		
		HIEX001SL Standing hamstring stretch	*
		HIEX002SL Supine hamstring stretch	2,3
		HIEX003SL Supine hamstring stretch	1
		HIEX004SL Supine hamstring stretch	1
		HIEX007SL Supine hamstring stretch	1
		HIEX008SL Supine hamstring stretch	2,3
		HIEX01 1SL Seated hamstring stretch	2,3
		HIEX012SB Seated bilateral hamstring stretch	*
		HIEX013SB Seated bilateral hamstring stretch	3
		HIEX014SL Standing hamstring stretch	2,3
	<i>HIEX.R.S</i>		
		HIEX001SR Standing hamstring stretch	*
		HIEX002SR Supine hamstring stretch	2,3
		HIEX003SR Supine hamstring stretch	1
		HIEX004SR Supine hamstring stretch	1
		HIEX007SR Supine hamstring stretch	1
		HIEX008SR Supine hamstring stretch	2,3
		HIEX01 1SR Seated hamstring stretch	2,3
		HIEX012SB Seated bilateral hamstring stretch	*
		HIEX013SB Seated bilateral hamstring stretch	3
		HIEX014SR Standing hamstring stretch	2,3
	<i>HIFL.L.S</i>		
		HIFL001SL Standing hip flexor stretch	2,3
		HIFL002SL Standing hip flexor stretch (partial)	1
		HIFL003SL Standing hip flexor stretch with back leg elevated	3

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HIFL.R.S

HIFLO01SR	Standing hip flexor stretch	2,3
HIFLO02SR	Standing hip flexor stretch (partial)	1
HIFLO03SR	Standing hip flexor stretch with back leg elevated	3

TRFL.C

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		TRFL001CB Abdominal crunch with feet elevated	1
		TRFL002CB Abdominal crunch with feet on the ground	1
		TRFL003CB Abdominal crunch with feet on the ground and lumbar support	1
		TRFL004CB Abdominal crunch with arms crossed and feet elevated	1,2
		TRFL005CB Abdominal crunch with hands behind the head and feet elevated	2
		TRFL006CB Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFL007CB Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFL008CB Abdominal crunch with arms overhead and feet elevated	2,3
		TRFL009CB Abdominal crunch with arms overhead and feet elevated	2,3
		TRFL012CB Hip raises (lower abdominal crunch)	3
		TRFL013CB Abdominal crunch with arms extended at the elbows, pointing forward	2,3
		TRFL014CB Isometric abdominal contraction	1
	<i>TRLE.S</i>		
		TREX001SB Cat stretch	*
		TREX002SB Supine, knees to chest	1,2
		TREX003SB Standing torso flexion	1,2
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX006SB Seated trunk flexion	1
		TREX008SB Seated full forward stretch	1,2
<i>DIS026</i>	Posterior pelvic tilt		
	<i>HIEX_L.S</i>		
		HIEX001SL Standing hamstring stretch	*
		HIEX002SL Supine hamstring stretch	2,3
		HIEX003SL Supine hamstring stretch	1

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H1EX004SL	Supine hamstring stretch	1
H1EX007SL	Supine hamstring stretch	1
H1EX008SL	Supine hamstring stretch	2,3
H1EX01 1SL	Seated hamstring stretch	2,3
H1EX012SB	Seated bilateral hamstring stretch	*
H1EX013SB	Seated bilateral hamstring stretch	3
H1EX014SL	Standing hamstring stretch	2,3

H1EX_RS

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		HIE001SR Standing hamstring stretch	*
		HIE002SR Supine hamstring stretch	2,3
		HIE003SR Supine hamstring stretch	1
		HIE004SR Supine hamstring stretch	1
		HIE007SR Supine hamstring stretch	1
		HIE008SR Supine hamstring stretch	2,3
		HIE011SR Seated hamstring stretch	2,3
		HIE012SB Seated bilateral hamstring stretch	*
		HIE013SB Seated bilateral hamstring stretch	3
		HIE014SR Standing hamstring stretch	2,3
	<i>HIFL_L.C</i>		
		HIFL001CB Squat	*
		HIFL002CB Unilateral squat	*
		TRFL010CL Abdominal crunch with unilateral hip flexion	2,3
		TRFL011CL Abdominal crunch with arms overhead and unilateral hip flexion	2,3
		TRFL012CB Hip raises (lower abdominal crunch)	3
	<i>HIFL_R.C</i>		
		HIFL001CB Squat	*
		HIFL002CB Unilateral squat	*
		TRFL010CR Abdominal crunch with unilateral hip flexion	2,3
		TRFL011CR Abdominal crunch with arms overhead and feet elevated	2,3
		TRFL012CB Hip raises (lower abdominal crunch)	3
	<i>TRFL.S</i>		
		TRFL001SB Cobra	*
	<i>TRLE.C</i>		
		TREX001CB Kneeling trunk extension	2,3
		TREX002CB Prone trunk extension	2,3
		TREX007CB Arm and hip extension	2,3
		TREX010CB Prone lumbar extension with hands on the lower back	*
		TREX011CB Prone lumbar extension with hands behind your head	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		TREX012CB Seated lumbar extension	1
<i>DIS029</i>	Lateral elevation of the hip to the left		
	<i>TRFL.S</i>		
		TRFL001 Cobra	
		SIB	

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>TRLE.C</i>			
		TREX001CB Kneeling trunk extension	2,3
		TREX002CB Prone trunk extension	2,3
		TREX007CB Arm and hip extension	2,3
		TREX010CB Prone lumbar extension with hands on the lower back	*
		TREX011CB Prone lumbar extension with hands behind your head	2,3
		TREX012CB Seated lumbar extension	1
<i>TRLF_L.S</i>			
		TRLF001 SL Standing lateral trunk flexor stretch	*
<i>TRLF_R.C</i>			
		TRFLO15CR Isometric abdominal contraction with leg extension	1
		TRLF001CR Lateral flexion with a dumbbell	2,3
		TRLF002CR Lateral flexion with a dumbbell	2,3
		TRLF003CR Lateral flexion with a bar	2,3
		TRLF004CR Lateral flexion with a bar	1
		TRLF005CR Lateral flexion with elastic resistance	*
		TRLF008CR Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CR Inclined lateral flexion with crossed arms, holding a weight	3
<i>TRTE.C</i>			
		TREX001CB Kneeling trunk extension	2,3
		TREX002CB Prone trunk extension	2,3
		TREX007CB Arm and hip extension	2,3
		TREX010CB Prone lumbar extension with hands on the lower back	*
		TREX011CB Prone lumbar extension with hands behind your head	2,3
		TREX012CB Seated lumbar extension	1

DIS030

Lateral elevation of the hip to

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
	the		
	right:		
	<i>TRFL.C</i>		
		TRFL00 Abdominal crunch with feet elevated 1CB	1
		TRFL00 Abdominal crunch with feet on the ground 2CB	1
		TRFL00 Abdominal crunch with feet on the ground and 3CB lumbar support	1
		TRFL00 Abdominal crunch with arms crossed and feet 4CB elevated	1,2
		TRFL00 Abdominal crunch with hands behind the head and 5CB feet elevated	2

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		TRFLO06CB Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFLO07CB Abdominal crunch with hands behind the head and feet on the floor	2,3
		TRFLO08CB Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO09CB Abdominal crunch with arms overhead and feet elevated	2,3
		TRFLO12CB Hip raises (lower abdominal crunch)	3
		TRFLO13CB Abdominal crunch with arms extended at the elbows, pointing forward	2,3
		TRFLO14CB Isometric abdominal contraction	1
	<i>TRLE.S</i>	TREX001 SB Cat stretch	*
		TREX002SB Supine, knees to chest	1,2
		TREX003SB Standing torso flexion	1,2
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX006SB Seated trunk flexion	1
		TREX008SB Seated full forward stretch	1,2
	<i>TRLF_L.C</i>	TRFLO15CL Isometric abdominal contraction with leg extension	1
		TRLF001CL Lateral flexion with a dumbbell	2,3
		TRLF002CL Lateral flexion with a dumbbell	2,3
		TRLF003CL Lateral flexion with a bar	2,3
		TRLF004CL Lateral flexion with a bar	1
		TRLF005CL Lateral flexion with elastic resistance	
		TRLF008CL Lateral flexion on an incline bench with arms across the chest	1,2
		TRLF009CL Inclined lateral flexion with crossed arms, holding a weight	3
	<i>TRLF_R.S</i>		

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		TRLF001SR Standing lateral trunk flexor stretch	*
	<i>TRTE.S</i>		
		TREX001 SB Cat stretch	*
		TREX004SB Standing torso flexion with arms reaching down	*
		TREX009SB Supine back extensor stretch propped up on your elbows	1
<i>DIS031</i>	Plantar flexion of the right foot		
	<i>ANDF_R.C</i>		
		ANDF001 CB Bilateral toe raises	2,3
		ANDF002CR Ankle dorsiflexion with elastic resistance	1,2
	<i>ANPF R.S</i>		
		AN PF001 SR Supine plantar flexor stretch	
		ANPF002SR Supine plantar flexor stretch with a towel	2
		ANPF003SR Standing plantar flexor stretch	1,2
		ANPF004SB Standing bilateral plantar flexor stretch	2
<i>DIS032</i>	Dorsiflexion of the right foot		
	<i>ANDF R.S</i>		
		ANDF001 SR Seated ankle dorsiflexor stretch	
	<i>ANPF R.C</i>		
		ANPF001 CR Standing plantar flexor isometric contraction	3
		ANPF002CB Bilateral isometric plantar flexor contraction with a ball	1

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		ANPF004CB Standing bilateral plantar flexor strengthening	1,2
		ANPF005CR Standing plantar flexor strengthening	3
		ANPF006CR Seated plantar flexor strengthening with elastic resistance	1,2
<i>DIS033</i>	Internal rotation of the right foot		
	<i>ANEV R</i>		
	<i>C</i>		
		ANEV001 CR Seated ankle eversion with elastic resistance	
	<i>HIER R</i>		
	<i>C</i>		
		HIER001 CR Side lying hip abductor f external rotator exercise	
		HIER002CB Seated bilateral hip abductor/external rotator exercise	
		HIER003CR Side lying hip abductor/external rotator contractions with a dumbbell	
	<i>HIEX L</i>		
	<i>S</i>		
		HIEX001 SL Standing hamstring stretch	
		HIEX002SL Supine hamstring stretch	2,3
		HIEX003SL Supine hamstring stretch	1
		HIEX004SL Supine hamstring stretch	1
		HIEX007SL Supine hamstring stretch	9
		HIEX008SL Supine hamstring stretch	2,3
		HIEX011SL Seated hamstring stretch	2,3
		HIEX012SB Seated bilateral hamstring stretch (legs apart)	
		HIEX013SB Seated bilateral hamstring stretch (legs together)	3
		HIEX014SL Standing hamstring stretch	2,3
		HIEX015SL Supine hamstring stretch	
	<i>HIEX R</i>		
	<i>C</i>		
		HIEX001 CB Supine pelvic tilt	
		HIEX003CR Supine pelvic tilt	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		HIEX004CR Supine pelvic tilt with one leg extended at the knee	3
		HIEX005CR Kneeling hip extensor exercise (leg flexed at the knee)	2
		HIEX006CR Kneeling hip extensor exercise (leg extended)	2,3
	<i>HIFL L.S</i>		
		HIFL001 SL Standing hip flexor stretch	2,3
		HIFL002SL Standing hip flexor stretch (partial)	1
		HIFL003SL Standing hip flexor stretch with back leg elevated	3
	<i>HIFL R. C</i>		
		HIFL001CB Squat	

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
DIS034	External rotation of the right foot	TRFL010CR	Abdominal crunch with unilateral hip flexion 2,3
		I CR	Abdominal crunch with arms overhead and unilateral hip flexion 2,3
		TRFL012CS	Hip raises (lower abdominal contraction) 3
		<i>AKIN R. C</i>	
		ANINCO01 CR	Seated ankle inversion with elastic resistance
		<i>HIER R.S</i>	
		HIER002SR	Supine hip external rotator stretch 3
		HIER003SR	Supine hip external rotator stretch 1
		HIER004SR	Supine assisted hip external rotator stretch 1,2
		HIER005SR	Supine assisted hip external rotator stretch 3
		HIER006SR	Seated assisted hip external rotator stretch 1
		HIER009SR	Supine assisted hip external rotator stretch 2,3
		HIER012SR	Prone hip external rotator stretch
		<i>HIE X R. S</i>	
		HIEX001SR	Standing hamstring stretch
		HIEX002SR	Supine hamstring stretch 2,3
		HIEX003SR	Supine hamstring stretch 1
		HIEX004SR	Supine hamstring stretch 1
		HIEX007SR	Supine hamstring stretch 1
		HIEX008SR	Supine hamstring stretch 2,3
		HIEX011SR	Seated hamstring stretch 2,3
		HIEX012SB	Seated bilateral hamstring stretch (legs apart)
		HIEX013SB	Seated bilateral hamstring stretch (legs together) 3
		HIEX014SR	Standing hamstring stretch 2,3
		HIEX015SR	Supine hamstring stretch
		<i>HIFL R.S</i>	
		HIFIL001SR	Standing hip flexor stretch 2,3
		HIFLO02SR	Standing hip flexor stretch (partial) 1
		HIFLO03SR	Standing hip flexor stretch with back leg elevated 3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
<i>HIIR R C</i>			
		H11R001CR	Side lying isometric hip adduction and internal rotation
		HIIR002CB	Supine knee-to-knee adduction and internal rotation
		HIIR003CB	Supine hip adduction and internal rotation with a ball
			TRFLDI

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
<i>DIS037</i>	Genu valgum right		
	<i>HIAB R. S</i>		
		HIAB001 SR Side lying hip abductor stretch	1,2,3
		HIAB005SR Standing hip abductor stretch	2,3
		HIAB006SR Standing hip abductor stretch with lateral flexion	2,3
		HIAB007SR Standing hip abductor stretch with lateral flexion	
	<i>HIAD R. C</i>		
		HIAD001 CR Side lying isometric hip adduction	
		HIAD002CR Supine hip adduction with elastic resistance	2,3
		HIAD003CR Side lying hip adduction with elastic resistance	2,3
		HIAD006CB Supine hip adduction with a ball between the knees	1,2
		HIAD010CB Supine hip adduction with a ball between the knees	1,2
		HIAD011CR Side lying hip adduction with a ball placed between your ankles	1,2
		HIAD012OR Side lying hip adduction with a ball between the knees and thighs	1,2
<i>DIS038</i>	Genu valgum left		
	<i>HIAB L. S</i>		
		HIAB001 SL Side lying hip abductor stretch	1,2,3
		HIAB005SL Standing hip abductor stretch	2,3
		HIAB006SL Standing hip abductor stretch with lateral flexion	2,3
		HIAB007SL Standing hip abductor stretch with lateral flexion	

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
<i>HIAD L. C</i>			
		HIAD001CL Side lying isometric hip adduction	1
		HIAD002CL Supine hip adduction with elastic resistance	2,3
		HIAD003CL Side lying hip adduction with elastic resistance	2,3
		HIAD006CB Supine hip adduction with a ball between the knees	1,2
		HIAD010CB Supine hip adduction with a ball between the knees	1,2
		HIAD011CL Side lying hip adduction with a ball placed between your ankles	1,2
		HIAD012CL Side lying hip adduction with a ball between the knees and thighs	1,2
<i>DIS039</i>	Genu varum right		
<i>HIAB R. C</i>			
		HIAB001CR Side lying hip abductor contraction	1
		HIAB002CR Side lying hip abductor contraction	

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Level s</i>
		HIAB003CB Seated bilateral hip abduction with elastic resistance	2,3
		HIAB004CR Side lying hip abduction exercise	1,2
		HIAB005CR Supine hip abduction exercise with elastic resistance	2,3
		HIAB006CR Side lying hip abductor exercise with dumbbells	2,3
		HIAB007CR Side lying hip abductor contraction with elastic resistance	2,3
		HIAB008CR Side lying hip abductor contraction with added weight	3
		HIAB011CR Standing hip abduction exercise with elastic resistance	2,3
		HIAB012CR Standing hip abduction exercise with elastic resistance	2,3
		HIAB013CR Standing hip abduction exercise with elastic resistance	2,3
	<i>HIAD R.S</i>		
		HIAD005SR Standing hip adductor stretch	
		HIAD008SR Kneeling hip adductor stretch	3
<i>DIS040</i>	<i>Genu varum left</i>		
	<i>HIAB L. C</i>		
		HIAB001CL Side lying hip abductor contraction	1
		HIAB002CL Side lying hip abductor contraction	1
		HIAB003CB Seated bilateral hip abduction with elastic resistance	2,3
		HIAB004CL Side lying hip abduction exercise	1,2
		HIAB005CL Supine hip abduction exercise with elastic resistance	2,3
		HIAB006CL Side lying hip abductor exercise with dumbbells	2,3
		HIAB007CL Side lying hip abductor contraction with elastic resistance	2,3
		HIAB008CL Side lying hip abductor contraction with added weight	
		HIAB011CL Standing hip abduction exercise with elastic	2,3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Level s</i>
		resistance	
		HIAB012CL Standing hip abduction exercise with elastic	2,3
		resistance	
		HIAB013CL Standing hip abduction exercise with elastic	2,3
		resistance	
	<i>HIAD</i>		
	<i>L.S</i>		
		HIAD005SL Standing hip adductor stretch	.
		HIAD008SL Kneeling hip adductor stretch	3
<i>DIS041</i>	Anterior deviation of the		
	shoulders		
	<i>SCAR C</i>		

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>	
		SCAD001 CB	Shoulder shrugs with dumbbells held in semi-supination on an incline	3
		SCAD002CB	Shoulder shrugs with dumbbells held in pronation on an incline bench	3
		SCAD003CS	Seated scapula adductor exercise	
	<i>SHFL.S</i>			
		SHFL005SB	Assisted shoulder flexor stretch	
	<i>SHIR. S</i>			
		SHIR006SR	Bent-over shoulder stretch	
<i>DIS042</i>	Posterior deviation of the shoulders			
	<i>SCAB. C</i>			
		SCAB001CB	Abdominal crunch with hands behind your head and feet on the floor	
	<i>SCAD. S</i>			
		SCAD001 SB	Scapula adductor stretch with both hands behind your back	
		SCAD007SB	Scapula adductor stretch with your arms crossed	1
	<i>SHFL. C</i>			
		SHFL001 CB	Standing bilateral shoulder flexor exercise with a ball	1,2
		SHFL002CB	Standing bilateral shoulder flexor exercise with a ball	1,2
		SHFL003CB	Shoulder flexor exercise with elastic resistance	1,2
		SHFL005CB	Forward shoulder flexion with 3 elastics	2,3
		SHFL006CB	Standing shoulder forward flexion with dumbbells	3
		SHFL007CB	Standing shoulder forward flexion and rotation with dumbbells	3
	<i>SHIR. C</i>			
		SHAB003CB	Bilateral shoulder abduction with dumbbells (palms backward)	3
		SHIR002CB	Prone shoulder internal rotator exercise with bar and elastics	
<i>DIS043</i>	External rotation of the left foot			

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
<i>ANIN L. C</i>			
		ANINC001 Seated ankle Inversion with elastic resistance	
		CL	
<i>HIER L. S</i>			
		HIER002SL Supine hip external rotator stretch	3
		HIER003SL Supine hip external rotator stretch	1
		HIER004SL Supine assisted hip external rotator stretch	1,2
		HIER005SL Supine assisted hip external rotator stretch	3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		HIER006SL Seated assisted hip external rotator stretch	1
		HIER009SL Supine assisted hip external rotator stretch	2,3
		HIER012SL Prone hip external rotator stretch	
	HIEX L. S		
		HIEX001SL Standing hamstring stretch	
		HIEX002SL Supine hamstring stretch	2,3
		HIEX003SL Supine hamstring stretch	1
		HIEX004SL Supine hamstring stretch	1
		HIEX007SL Supine hamstring stretch	1
		HIEX008SL Supine hamstring stretch	2,3
		HIEX011SL Seated hamstring stretch	2,3
		HIEX012SB Seated bilateral hamstring stretch (legs apart)	
		HIEX013SB Seated bilateral hamstring stretch (legs together)	3
		HIEX014SL Standing hamstring stretch	2,3
		HIEX015SL Supine hamstring stretch	
	HIFL L. S		
		HIFL001SL Standing hip flexor stretch	2,3
		HIFL002SL Standing hip flexor stretch (partial)	1
		HIFL003SL Standing hip flexor stretch with back leg elevated	3
	HIIR L. C		
		HIIR001 CL Side lying isometric hip adduction and internal rotation	
		HIIR002CB Supine knee-to-knee adduction and internal rotation	
		HIIR003CB Supine hip adduction and internal rotation with a " ball	
	Internal rotation of the left foot		
	ANEV L. C		
		ANEV001 CL Seated ankle eversion with elastic resistance	
	HIER L. C		
		HIER001 CL Side lying hip abductor / external rotator exercise	
		HIER002C B Seated bilateral hip abductor/external rotator exercise	

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Levels</i>
		HI ER003CL	Side lying hip abductor/external rotator contractions with a dumbbell
		<i>HIEX L. C</i>	
		HIEX001C B	Supine pelvic tilt
		HIEX003C L	Supine pelvic tilt
		HIEX004C L	Supine pelvic tilt with one leg extended at the knee
			2,3 3

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<i>Deviations</i>	<i>Actions</i>	<i>Exercises</i>	<i>Leads</i>
		HIEX005CL Kneeling hip extensor exercise (leg flexed at the knee)	2
		HIEX006CL Kneeling hip extensor exercise (leg extended)	2,3
	<i>HIEX R. S</i>		
		HIEX001SR Standing hamstring stretch	
		HIEX002SR Supine hamstring stretch	2,3
		HIEX003SR Supine hamstring stretch	1
		HIEX004SR Supine hamstring stretch	1
		HIEX007SR Supine hamstring stretch	1
		HIEX008SR Supine hamstring stretch	2,3
		HIEX011SR Seated hamstring stretch	2,3
		HIEX012SB Seated bilateral hamstring stretch (legs apart)	
		HIEX013SB Seated bilateral hamstring stretch (legs together)	3
		HIEX014SR Standing hamstring stretch	2,3
		HIEX015SR Supine hamstring stretch	
	<i>HIFL L. C</i>		
		HIFL001CB Squat	
		TRFLO10CL Abdominal crunch with unilateral hip flexion	2,3
		TRFLO11CL Abdominal crunch with arms overhead and unilateral hip flexion	2,3
		TRFLO12CB Hip raises (lower abdominal contraction)	3
	<i>HIFL R.S</i>		
		HIFL001SR Standing hip flexor stretch	2,3
		HIFLO02SR Standing hip flexor stretch (partial)	1
		HIFLO03SR Standing hip flexor stretch with back leg elevated	3

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Table 3

Body part	Action code	Description
Ankle (AN)	ANDL	Ankle dorsiflexion
	ANPF	Ankle plantar flexion
	ANIN	Ankle inversion
	ANEV	Ankle eversion
Elbow(EL)	ELFL	Elbow flexion
	ELEX	Elbow extension
	ELSU	Elbow supination (of forearm)
	ELPR	Elbow pronation (of forearm)
Hip (HI)	HIFL	Hip flexion
	HIEX	Hip extension
	HIAD	Hip adduction
	HIAB	Hip abduction
Knee (KN)	KNEX	Knee extension
	KNFL	Knee flexion
	KNIR	Knee internal rotation
	KNER	Knee external rotation
Neck Head (NH)	NHFL	Neck Head flexion
	NHEX	Neck Head extension
	NHFL	Neck Head lateral flexion
	NHIR	Neck Head ipsi-rotation
	NHCR	Neck Head contra-rotation
Scapula (SC)	SCBL	Scapula elevation
	SCDE	Scapula depression
	SCAB	Scapula abduction
	SCAD	Scapula adduction

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Body part	Action code	Description
	SCER	Scapula external rotation
	SCIR	Scapula internal rotation
	SCAN	Scapula anterior inclination
Shoulder (SH)	SHAB	Shoulder abduction
	SHAD	Shoulder adduction
	SHER	Shoulder external rotation
	SHFL	Shoulder flexion
	SHIR	Shoulder internal rotation
	SHEX	Shoulder extension
Trunk (TR)	TRFL	Trunk flexion
	TRLF	Trunk lateral flexion
	TRLE	Trunk lumbar extension
	TRTE	Trunk thoracic extension
	TRCE	Trunk cervical extension
	TRRO	Trunk rotation
Wrist (WR)	WRFL	Wrist flexion
	WREX	Wrist extension
	WRAB	Wrist abduction
	WRAD	Wrist adduction

- 5 In a preferred embodiment of the present invention, the system generates a complete list of deviations for the client, in order of corrective priority. Priority is given to those deviations of body segments that are most perturbing to overall postural stability. Severity is also included in the decision making process, and only parameters exceeding critical values from correct vertical or horizontal alignment (of distance or angle) are considered deviations. These critical values were based on

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consultations with clinicians treating postural disorders and form a preliminary identification of severity. One of the advantages of the current system is that we will have access to large numbers of normative data from which severity rankings can be revised, as necessary. The first three ranked deviations in order of priority are
5 automatically included in the design of the client's exercise and stretching program. The remaining deviations may be manually selected by the health-care professional based on his or her clinical experience and familiarity with the patient.

Table 4 shows the priority factors given to postural deviations.

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Table 4

Deviations

Code DIS001

Level	Name	Group	Factor	Priority	Actions	Formula
1	Translation of the	Neck Head	50	50	NHIF_R,C,NHIF_LS	$((FA02X + FA03X) / 2) \geq FA06X + 10$ AND $((FA02X + FA03X) / 2) < FA06X + 20$ AND $(ABS(FA02X - FA04X) < 10)$
2	Translation of the	Neck Head	50	100	NHIF_R,C,NHIF_LS	$((FA02X + FA03X) / 2) \geq FA06X + 20$ AND $(ABS(FA02X - FA04X) < 10)$

Code DIS002

Level	Name	Group	Factor	Priority	Actions	Formula
1	Translation of the	Neck Head	50	50	NHIF_L,C,NHIF_RS	$((FA02X + FA03X) / 2) \leq FA06X - 10$ AND $((FA02X + FA03X) / 2) > FA06X - 20$ AND $(ABS(FA02X - FA04X) < 10)$
2	Translation of the	Neck Head	50	100	NHIF_L,C,NHIF_RS	$((FA02X + FA03X) / 2) \leq FA06X - 20$ AND $(ABS(FA02X - FA04X) < 10)$

Code DIS003

Level	Name	Group	Factor	Priority	Actions	Formula
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Deviations

Code DIS001

Level	Name	Group	Factor	Priority	Actions	Formula
1	Protrusion of the h	Neck Head	50	50	TRCE.C,NHEX.S,NHFL.C	(SD01X >= SD04X + 25) AND (SD01X < SD04X + 50)
2	Protrusion of the h	Neck Head	50	100	TRCE.C,NHEX.S,NHFL.C	(SD01X >= SD04X + 50)

Code DIS004

Level	Name	Group	Factor	Priority	Actions	Formula
1	Posterior deviation	Neck Head	50	50	TRCE.S,NHEX.S,NHFL.S,NHFL.C	(SD01X <= SD04X - 25) AND (SD01X > SD04X - 50)
2	Posterior deviation	Neck Head	50	100	TRCE.S,NHEX.S,NHFL.S,NHFL.C	(SD01X <= SD04X - 50)

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DIS005

Level	Name	Group	Factor	Priority	Actions	Formula
1	Flexion of the hea	Neck Head	50	50	TRCE.C,NHFL.C,NHEX.S	(SD02X >= SD03X + 20) AND (SD02X < SD03X + 35)
2	Flexion of the hea	Neck Head	50	100	TRCE.C,NHFL.C,NHEX.S	(SD02X >= SD03X + 35)

DIS006

Level	Name	Group	Factor	Priority	Actions	Formula
1	Extension of the h	Neck Head	50	50	NHEX.C,NHFL.S,TRCE.C	(SD02X <= SD03X - 20) AND (SD02X > SD03X - 35)
2	Extension of the h	Neck Head	50	100	NHEX.C,NHFL.S,TRCE.C	(SD02X <= SD03X - 35)

DIS009

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral flexion of t	Neck Head	50	50	NHLE.L.C,NHLE.R.S	(FA02X <= FA 04X - 10) AND (FA02X > FA04X - 20)
2	Lateral flexion oft	Neck Head	50	100	NHLE.L.C,NHLE.R.S	(FA02X <= FA04X - 20)

DIS010

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral flexion of t	Neck Head	50	50	NHLE.R.C,NHLE.L.S	(FA02X >= FA04X + 10) AND (FA02X < FA04X + 20)

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Code	Level	Name	Group	Factor	Priority	Actions	Formula
2		Lateral flexion of Neck Head	50	100		NHLF_R,C,NHLF_LS	(FA02X >= FA04X + 20)
		DISO11					
1		Lateral translation Trunk	40	40		TRLF_L,C,TRLF_R,S,TRTE_R,S	(FA06 >= FA10 + 20) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 <= FP08 - 20) AND (ABS(FP04Y - FP05Y) < 25) AND (FA06 < FA10 + 40) AND (FP03 > FP08 - 40)
2		Lateral translation Trunk	40	80		TRLF_L,C,TRLF_R,S,TRTE_R,S	(FA06 >= FA10 + 40) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 <= FP08 - 40) AND (ABS(FP04Y - FP05Y) < 25)

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Code DIS012

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral translation	Trunk	40	40	TRLF_R,C,TRLF_LS,TRTE_LS	(FA06 <= FA10 - 20) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 >= FP08 + 20) AND (ABS(FP04Y - FP05Y) < 25) AND (FA06 > FA10 - 40) AND (FP03 < FP08 + 40)
2	Lateral translation	Trunk	40	80	TRLF_R,C,TRLF_LS,TRTE_LS	(FA06 <= FA10 - 40) AND (ABS(FA05Y - FA07Y) < 25) AND (FP03 >= FP08 + 40) AND (ABS(FP04Y - FP05Y) < 25)

Code DIS013

Level	Name	Group	Factor	Priority	Actions	Formula
1	Anterior deviation	Trunk +	41	41	TRLE_C,HIPL_LS,HIPL_R,S,HIEX_S,SHAD_S,SCAD_C	(SD04X >= SD07X + 20) AND (SD04X > SD07X + 40)
2	Anterior deviation	Trunk +	41	82	TRLE_C,HIPL_LS,HIPL_R,S,HIEX_S,SHAD_S,SCAD_C	(SD04X >= SD07X + 40)

Code DIS014

Level	Name	Group	Factor	Priority	Actions	Formula
1	Posterior deviation	Trunk +	41	41	TRLE_S,TRTE_S,TRLE_C,SCAD_S,HI	(SD04X <= SD07X - 20) AND (SD04X > SD07X -

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Code	2	Posterior deviation	Trunk +	41	82	FL_LS,HIFL_RS 40) TRLE_S,TRTE_S,TRFL_C,SCAD_S,HI (SD04X <= SD07X - 40) FL_LS,HIFL_RS
		DIS015				
Level	Name					
	Group					
1	Trunk flexion					
	Trunk					
				40	40	TRLE_C,TRTE_C,HIFL_LS,HIFL_R FALSE S,NHEX_S,HIEX_S,SHAD_S
				Formula		

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Code DIS016

Level	Name	Group	Factor	Priority Actions	Formula
1	Trunk extension	Trunk	40	40	$TRLF_LS, TRLF_RS, TRTES, SCAD$ $.S, SCAB, C, NHGX_LS, NHGX_RS$ FALSE

Code DIS019

Level	Name	Group	Factor	Priority Actions	Formula
1	Lateral flexion of t	Trunk +	41	41	$TRLF_LC, TRLF_RS$ $(FA05Y <= FA07Y - 25) \text{ AND } (FP04Y >= FP05Y$ $+ 25) \text{ AND } (FA06X <= FA10X - 25) \text{ AND } (FP03X$ $>= FP08X + 25) \text{ AND } (FA05Y > FA07Y - 50)$ $\text{ AND } (FP04Y < FP05Y + 50) \text{ AND } (FA06X >$ $FA10X - 50) \text{ AND } (FP03X < FP08X + 50)$ $(FA05Y <= FA07Y - 50) \text{ AND } (FP04Y >= FP05Y$ $+ 50) \text{ AND } (FA06X <= FA10X - 50) \text{ AND } (FP03X$ $>= FP08X + 50)$
2	Lateral flexion of t	Trunk +	41	82	$TRLF_LC, TRLF_RS$ $(FA05Y <= FA07Y - 50) \text{ AND } (FP04Y >= FP05Y$ $+ 50) \text{ AND } (FA06X <= FA10X - 50) \text{ AND } (FP03X$ $>= FP08X + 50)$

Code DIS020

Level	Name	Group	Factor	Priority Actions	Formula
1	Lateral flexion of t	Trunk +	41	41	$TRLF_RC, TRLF_LS$ $(FA05Y >= FA07Y + 25) \text{ AND } (FP04Y <=$ $FP05Y - 25) \text{ AND } (FA06X >= FA10X + 25) \text{ AND}$ $(FP03X <= FP08X - 25) \text{ AND } (FA05Y < FA07Y +$

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2	Lateral flexion of t Trunk +	41	82	TRLF_R,C,TRLF_LS	50) AND (FP04Y > FP05Y - 50) AND (FA06X <
					FA10X + 50) AND (FP03X > FP08X - 50)
					(FA05Y >= FA07Y + 50) AND (FP04Y <=
					FP05Y - 50) AND (FA06X >= FA10X + 50) AND
					(FP03X <= FP08X - 50)
DIS021					
Level	Name	Group	Factor	Priority Actions	Formula
1	Translation of the Hip		60	HIAB_L,C,HIAD_R,C,HIAB_R,S,HTA D_LS	(FA10X >= FA17X + 20) AND (FA10X < FA17X + 40)
2	Translation of the Hip		60	HIAB_L,C,HIAD_R,C,HIAB_R,S,HTA D_LS	(FA10X >= FA17X + 40)

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Code DIS022

Level	Name	Group	Factor	Priority	Actions	Formula
1	Translation of the Hip	Hip	60	60	HIAB_R,C,HIAD_L,C,HIAB_LS,HIA D_RS	(FA17X >= FA10X + 20) AND (FA17X < FA10X + 40)
2	Translation of the Hip	Hip	60	120	HIAB_R,C,HIAD_L,C,HIAB_LS,HIA D_RS	(FA17X >= FA10X + 40)

Code DIS023

Level	Name	Group	Factor	Priority	Actions	Formula
1	Anterior translatio	Hip +	61	61	HIEX_C,HIFL_LS,HIFL_RS	(SD07X >= SD11X + 20) AND (SD07X < SD11X + 40)
2	Anterior translatio	Hip +	61	122	HIEX_C,HIFL_LS,HIFL_RS	(SD07X >= SD11X + 40)

Code DIS024

Level	Name	Group	Factor	Priority	Actions	Formula
1	Posterior translatio	Hip +	61	61	HIFL_L,C,HIFL_R,C,HIEX_LS,HIEX _RS	(SD11X >= SD07X + 20) AND (SD11X < SD07X + 40)
2	Posterior translatio	Hip +	61	122	HIFL_L,C,HIFL_R,C,HIEX_LS,HIEX RS	(SD11X-SD07X + 40)

Code DIS025

Level	Name	Group	Factor	Priority	Actions	Formula
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1	Anterior pelvic tilt	Hip +	61	61	TRFLC, HIEXC, TRLES, HIFL_LS, HIFL_RS, HIEX_LS, HIEX_RS	(SD07X - SD09X >= 10) AND (SD07X - SD09X < 20)
2	Anterior pelvic tilt -	Hip +	61	122	TRFLC, HIEXC, TRLES, HIFL_LS, HIFL_RS, HIEX_LS, HIEX_RS	(SD07X - SD09X >= 20)

Code DN026

Level	Name	Group	Factor	Priority	Actions	Formula
1	Posterior pelvic tilt	Hip +	61	61	TRFLC, HIFL_LS, HIFL_RS, HIEX_LS, HIEX_RS	(SD09X - SD07X >= 10) AND (SD09X - SD07X < 20)
2	Posterior pelvic tilt	Hip +	61	122	TRFLC, HIFL_LS, HIFL_RS, HIEX_LS, HIEX_RS	(SD09X - SD07X >= 20)

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Code DIS029

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral elevation o	Hip	60	60	TRLEC,TRTEC,TRFLS,TRLF_R,C, TRLF_LS	(FA11 - FA09 >= 10) AND (FA11 - FA09 < 20)
2	Lateral elevation o	Hip	60	120	TRLEC,TRTEC,TRFLS,TRLF_R,C, TRLF_LS	(FA11 - FA09 >= 20)

Code DIS030

Level	Name	Group	Factor	Priority	Actions	Formula
1	Lateral elevation o	Hip	60	60	TRLES,TRTES,TRFLC,TRLF_L,C, TRLF_RS	(FA09 - FA11 >= 10) AND (FA09 - FA11 < 20)
2	Lateral elevation o	Hip	60	120	TRLES,TRTES,TRFLC,TRLF_L,C, TRLF_RS	(FA09 - FA11 >= 20)

Code DIS031

Level	Name	Group	Factor	Priority	Actions	Formula
1	Plantar flexion of t	Unknown	0	0	ANDE_R,C,ANPF_RS	(SD10X - SD11X >= 20) AND (SD10X - SD11X < 40)
2	Plantar flexion of t	Unknown	0	0	ANDE_R,C,ANPF_RS	(SD10X - SD11X >= 40)

Code DIS032

Level	Name	Group	Factor	Priority	Actions	Formula
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1	Dorsiflexion of the	Unknown	0	0	ANPF_R,C,ANDE_R,S	(SD11X - SD10X >= 20) AND (SD11X - SD10X < 40)
2	Dorsiflexion of the	Unknown	0	0	ANPF_R,C,ANDE_R,S	(SD11X - SD10X >= 40)
<i>DJS033</i>						
Level	Name	Group	Factor	Priority	Actions	Formula
1	Internal rotation of Ankle +		11	11	HIFL_R,C,HIEY_R,C,HIER_R,C,HIF L_LS,HIEY_L,S,ANEV_R,C	(FA19X - FA16X >= 10) AND (FA19X - FA16X < 20)
2	Internal rotation of Ankle +		11	22	HIFL_R,C,HIEY_R,C,HIER_R,C,HIF L_LS,HIEY_L,S,ANEV_R,C	(FA19X - FA16X >= 20)

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Code DIS034

Level	Name	Group	Factor	Priority	Actions	Formula
1	External rotation o	Ankle +	11	11	HIIR_R,C,HIIFL_R,S,HIEX_R,S,HIER_R,S,ANIN_R,C	(FA16X - FA19X >= 10) AND (FA16X - FA19X < 20)
2	External rotation o	Ankle +	11	22	HIIR_R,C,HIIFL_R,S,HIEX_R,S,HIER_R,S,ANIN_R,C	(FA16X - FA19X >= 20)

Code DIS037

Level	Name	Group	Factor	Priority	Actions	Formula
1	Genu valgum right	Knee	20	20	HIAD_R,C,HIAB_R,S	(FA14X - FA09X >= 10) AND (FA14X - FA16X >= 10) AND ((FA14X - FA09X < 20) OR (FA14X - FA16X < 20))
2	Genu valgum right	Knee	20	40	HIAD_R,C,HIAB_R,S	(FA14X - FA09X >= 20) AND (FA14X - FA16X >= 20)

Code DIS038

Level	Name	Group	Factor	Priority	Actions	Formula
1	Genu valgum left	Knee	20	20	HIAD_L,C,HIAB_L,S	(FA11X - FA15X >= 10) AND (FA18X - FA15X >= 10) AND ((FA11X - FA15X < 20) OR (FA18X - FA15X < 20))
2	Genu valgum left -	Knee	20	40	HIAD_L,C,HIAB_L,S	(FA11X - FA15X >= 20) AND (FA18X - FA15X >= 20)

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20)

DIS039

Code

Level	Name	Group	Factor	Priority	Actions	Formula
1	Genu varum right	Knee	20	20	HIAB_R_C, HIAD_R_S	(FA09X - FA14X >= 10) AND (FA16X - FA14X >= 10) AND ((FA09X - FA14X < 20) OR (FA16X - FA14X < 20))
2	Genu varum right - Knee		20	40	HIAB_R_C, HIAD_R_S	(FA09X - FA14X >= 20) AND (FA16X - FA14X >= 20)

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Code	Level	Name	Group	Factor	Priority	Actions	Formula
DIS040	1	Genu varum left	Knee	20	20	HIAB_L,C,HIAD_L,S	(FA15X - FA11X >= 10) AND (FA15X - FA18X >= 10) AND ((FA15X - FA11X < 20) OR (FA15X - FA18X < 20))
	2	Genu varum left -	Knee	20	40	HIAB_L,C,HIAD_L,S	(FA15X - FA11X >= 20) AND (FA15X - FA18X >= 20)

Code	Level	Name	Group	Factor	Priority	Actions	Formula
DIS041	1	Anterior deviation	Shoulder	30	30	SCAD,C,SHFL,S,SHIR,S	(SD04X - SD01X >= 10) AND (SD04X - SD07X >= 10) AND ((SD04X - SD01X < 20) OR (SD04X - SD07X < 20))
	2	Anterior deviation	Shoulder	30	60	SCAD,C,SHFL,S,SHIR,S	(SD04X - SD01X >= 20) AND (SD04X - SD07X >= 20)

Code	Level	Name	Group	Factor	Priority	Actions	Formula
DIS042	1	Posterior deviation	Shoulder	30	30	SCAD,S,SHFL,C,SHIR,C,SCAB,C	(SD01X - SD04X >= 10) AND (SD07X - SD04X >= 10) AND ((SD01X - SD04X < 20) OR (SD07X - SD04X < 20))

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2 Posterior deviation Shoulder 30 60 SCAD,S,SHFL,C,SHIR,C,SCAB,C (SD01X - SD04X >= 20) AND (SD07X - SD04X >= 20)

Code DIS043

Level	Name	Group	Factor	Priority	Actions	Formula
1	External rotation o	Ankle +	11	11	HIR_L,C,HIFL_LS,HIEEX_LS,HIER_LS,ANIN_LC	(FA20X - FA18X >= 10) AND (FA20X - FA18X < 20)
2	External rotation o	Ankle +	11	22	HIR_L,C,HIFL_LS,HIEEX_LS,HIER_LS,ANIN_LC	(FA20X - FA18X >= 20)

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Code	DIS044					Formula
	Level	Name	Group	Factor	Priority	Actions
	1	Internal rotation of Ankle +		11	11	HIFL_L_C,HIEFL_C,HIER_L_C,HIFL (FA18X - FA20X >= 10) AND (FA18X - FA20X < 20)
	2	Internal rotation of Ankle +		11	22	HIFL_L_C,HIEFL_C,HIER_L_C,HIFL (FA18X - FA20X >= 20)
						R_C,HIER_R_S,ANEV_L_C _R_S,HIEFL_R_S,ANEV_L_C

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As stated previously, each deviation is linked to corrective actions and these actions, in turn, are linked to appropriate exercises and stretching routines to treat the deviation. The corrective actions are linked to their deviations by a code that specifies the type of action and exercise required to correct the identified deviation. Every exercise is associated with a level of difficulty from one to three. When beginning a biomechanical assessment, the health-care professional indicates his client's activity level from one to three (level 1 = inactive, level 2 = moderately active, level 3 = highly active and * = all levels of activity). Only those exercises matching the client's activity level are selected to treat any particular deviation.

10 A client's exercise schedule is divided into three sessions: the first is of two weeks in duration and the last two are of four weeks duration. When an action group contains numerous exercises, the system always selects only the first three exercises and inserts one into each session. When there is only one exercise applicable, it is included in all three sessions. If there are two exercises applicable, the first is slotted
15 into session 1, and the second one into sessions 2 and 3. There is a maximum of twelve exercises applicable per session. When the system calculates more than twelve exercises applicable per session, the user is requested to delete a deviation. This self-regulating process ensures that the entire 10-week exercise program does not include more than thirty-six exercises, and that not more than 12 are prescribed in one week in
20 order to respect a maximum time budget allowed.

In one other embodiment of the present invention, an artificial neural network is trained to select exercises based on biomechanical segments points coordinates without passing through all previously shown calculations.

The patient's personal information, images, biomechanical assessment, postural deviations, corrective actions and associated exercises and stretches are
25 presented in the Biomechanical Assessment Report that is printed by the practitioner. A page from a sample Biomechanical Assessment Report is presented in Figure 13. Presented are personal information on the patient (1), lateral view image of the patient with markers (2), and biomechanical parameters. Presented in Figure 14 is a page from
30 the same sample Biomechanical Assessment Report that includes specification of the patient's postural deviations and the associated exercises and stretching. Presented in

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Fig. 15 is a page from the Postural Analysis Report that displays the exercise schedule generated in the Biomechanical Assessment process. This figure details the personalized exercise routines for the 10-week treatment period. Finally, presented in Fig. 16 is another page from the Biomechanical Assessment Report illustrating and describing a few of the exercises of the exercise schedule. All of the above information is generated automatically (and modifiable manually) by the system.

In a preferred embodiment of the present invention, after the patient has completed the exercise routines, he or she can return for a follow-up evaluation. Feedback is given by the health-care practitioner and new images of the patient are taken in order to reevaluate deviations and priorities. A comparative Biomechanical Assessment Report is generated comparing two assessments. The goal is to assess the effects of treatment and modify the exercise regime, if necessary. A quantified analysis of improvement is therefore provided and both the patient and health-care practitioner can visualize progress towards ideal postural alignment. In another embodiment of the present invention, feedback is provided directly by the patient through the web site, such information being used as a complement in the postural evaluation and in further exercise selection.

Importantly, all biomechanical data linked to personal information parameters such as height, weight, and age are stored centrally. In one embodiment of the invention, correlation is executed between the personal information parameters, the exercises selected in the Biomechanical Assessment and between the improvement of the patient's condition. This correlation allows the determination of the exercises which are more efficient for the different elements associated with the patient such as the deviation severity, the age, the gender or the activity level. Parameters used in deviation-exercises correlation are adjusted based on the effectiveness of the exercise program to correct deviations and the exercise program is repeatedly varied until the effectiveness of the exercises is optimized. An important advantage of having calculations performed centrally rather than on locally arranged software, is that improvements and modifications to the system can be made instantaneously across users without delays caused by the more standard transmission of software updates. This is a highly distinguishing aspect of our Biomechanical Assessment system. An additional distinguishing feature is that biomechanical assessments can be performed

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at remote locations, as the digital image acquisition can be performed virtually anywhere. Web-based technology is ideally placed to bring cutting-edge health care to potentially disadvantage geographical locations.

While the invention has been described in connection with specific
5 embodiments thereof, it will be understood that it is capable of further modification and
this application is intended to cover any variations, uses, or adaptations of the invention
following, in general, the principles of the invention and including such departures
from the present disclosure as come within known or customary practice within the art
to which the invention pertains and as may be applied to the essential features here in
10 before set forth, and as follows in the scope of the appended claims.

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CLAIMS

1. A method of acquiring biomechanical position data for use in postural analysis, the method comprising the steps of:
 - a) selecting a plurality of marker positions referenced with respect to an anatomy of a patient by one of:
 - skin surface features having minimal variability from one patient to the next; and
 - skeletal features palpable from a skin surface of the patient;
 - b) attaching a scanable marker on the patient at each of the marker positions, the step of attaching including palpating the patient to define at least some of the marker positions;
 - c) instructing the patient to stand relaxed and in normal posture; and
 - d) scanning the markers attached to the patient to obtain position data for each of the marker positions.
2. The method as claimed in claim 1, wherein the patient is scanned from a front, side and rear viewpoint.
3. The method as claimed in claim 2, wherein the step of scanning comprises photographing the patient against a backdrop, the markers comprising contrasting visual
4. The method as claimed in claim 3, wherein the step of photographing comprises using a digital camera with a flash to obtain digital images, the markers comprising retroreflective markers.
5. The method as claimed in claim 4, wherein some of the markers are scanned from more than one of the viewpoints and comprise retroreflective spheres.

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6. The method as claimed in claim 3, wherein the step of instructing the patient to stand relaxed and in normal posture comprises requesting the patient to walk in place prior to standing still.
7. The method as claimed in claim 4, wherein the step of scanning comprises automatically recognizing the markers and the reference marker points in the digital images using a computer.
8. The method as claimed in claim 7, wherein the computer comprises a user interface and, when the computer recognizes too many or too few of the markers, input is accepted via the user interface to remove or add, with reference to the digital images, the position coordinates of the markers which the computer incorrectly recognized or failed to recognize.
9. A method for calculating postural deviation values in a patient comprising the steps of:
 - a) obtaining position data identifying a position in space of body segments of the patient while standing relaxed and in normal posture, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles;
 - b) obtaining weight data of the patient;
 - c) calculating vertical and horizontal plumb line using the position data;
 - d) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data.
10. The method as claimed in claim 9, wherein the angle and distance of deviation values are referenced with respect to average or normal values.
11. The method as claimed in claim 9, further comprising a step of calculating an effective weight or stress of at least one of the body segments using an estimated weight of the at least one body segment and the deviation values.

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12. The method as claimed in claim 9, wherein the deviation values are calculated for all of the body segments.

13. A method of selecting exercises for improving tonicity and correcting posture in a patient, the method comprising the steps of:

- a) obtaining biomechanical position data of the patient while standing relaxed and in normal posture, the position data indicative of postural problems requiring correction;
- b) ranking the postural deviations by severity and priority;
- c) correlating the position data with exercises for strengthening or stretching specific muscles or muscle groups to obtain ranking data for the exercises;
- d) compiling an exercise program for the patient based on the ranking data.

14. The method as claimed in claim 13, wherein the step of compiling comprises manually selecting exercises from a ranked list of exercises.

15. The method as claimed in claim 14, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

16. The method as claimed in claim 13, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the step of correlating comprising correlating the position data with the sets of exercises, and the exercise program comprising a series of the sets of exercises.

17. The method as claimed in claim 13, wherein the position data identifies a position in space of body segments of the patient, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles, and the step of correlating comprises:

- a) calculating a center of mass plumb line position value using the position data and the weight data;

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b) calculating for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data;

c) comparing the deviation values to normal values for the at least some of the body segments to obtain deviation priority values;

d) ranking the deviation priority values according to an order of severity or importance; and

e) determining the ranking data based on an association of the exercises with body segment deviations in accordance with the order of severity or importance.

18. The method as claimed in claim 17, wherein the step of ranking the deviation priority values according to an order of severity or importance comprises manually selecting deviations to be corrected by the exercise program, the order of severity or importance reflecting those deviations manually selected.

19. The method as claimed in claim 18, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, and the exercise program comprising a series of the sets of exercises.

20. The method as claimed in claim 19, wherein the exercise program is limited to a maximum number of exercises, the step of manually selecting deviations is automatically restricted when a maximum number of exercises corresponding to the selected deviations exceeds the maximum number for the exercise program.

21. The method as claimed in claim 13, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

22. The method as claimed in claim 21, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

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23. The method as claimed in claim 17, wherein the step of compiling comprises repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

24. The method as claimed in claim 23, wherein the step of compiling comprises including ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

25. The method as claimed in claim 13, further comprising steps of:

- a) obtaining, after completing of the exercise program, new biomechanical position data of the patient while standing relaxed and in normal posture;
- b) evaluating an effectiveness of the exercises in the exercise program for correcting the postural problems; and
- c) adjusting parameters used in the step of correlating for future patients based on the effectiveness evaluated in the previous step.

26. The method as claimed in claim 25, wherein the exercise program is repeatedly varied until the effectiveness of the exercises is optimized.

27. The method as claimed in claim 26, wherein the steps of correlating, evaluating and adjusting are carried out using a centralized shared database of the parameters used in the step of correlating for a large number of patients.

28. The method as claimed in claim 25, wherein the parameters include at least one of age, gender and an activity level of the patient.

29. A method of providing posture health care using a distributed system, the method comprising the steps of:

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- a) obtaining personal data of a patient, the personal data including weight, height, gender and activity data of the patient, and obtaining posture anatomical reference position data of the patient at a biomechanical measurement station;
- b) processing the personal and position data using data stored in a remote central database to obtain preliminary postural deviation assessment data;
- c) providing the preliminary postural deviation assessment data to one of a health-care practitioner and the patient;
- d) obtaining corrected postural deviation assessment data from one of the health-care practitioner and the patient; and
- e) modifying the data stored in the central database using the corrected data.

30. The method as claimed in claim 29, wherein the preliminary postural deviation assessment data comprises a ranked list of deviations and a preliminary selection of the deviations to be included in a therapeutic exercise program, and the corrected data comprises a corrected selection of the deviations to be included in a therapeutic exercise program.

31. The method as claimed in claim 29, wherein:

the preliminary postural deviation assessment data comprises a set of therapeutic exercises of an exercise program;

the corrected data comprises new posture anatomical reference position data of the patient obtained after completion of the exercise program; and

step (e) comprises processing the new reference position data to determine an effectiveness of the therapeutic exercises in correcting postural deviations and modifying accordingly the data stored in the central database.

32. The method as claimed in claim 29, wherein:

step (a) comprises validating completeness of the reference position data at the biomechanical measurement station and transmitting the personal and position data to a central server;

step (b) is carried out at the central server;

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step (c) comprises transmitting the preliminary postural deviation assessment data from the central server to one of the health-care practitioner and the patient;
step (d) comprises transmitting the corrected data to the central server; and
step (e) is carried out by the central server.

33. The method as claimed in claim 32, wherein the biomechanical measurement station includes a health-care practitioner client station in communication with the central server.

34. The method as claimed in claim 33, wherein the client station uses a web browser interface to communicate with the central server, the central server providing a secure connection to a biomechanical assessment report web document for the patient.

35. An apparatus for acquiring biomechanical position data for use in postural analysis of a patient, the apparatus comprising:

- a) scanable markers for attaching on said patient at preselected marker positions; and
- b) scanner for obtaining position data for each of the marker position.

36. The apparatus of claim 35, wherein the markers comprise an adhesive layer for sticking to the patient.

37. The apparatus of claim 35, wherein the markers further comprise retroreflective material.

38. The apparatus of claim 37, wherein said scanner is a digital camera with a flash for obtaining digital images.

39. The apparatus of claim 38, further comprising a computer for automatically recognizing the markers and for referencing marker points in digital images.

40. The apparatus of claim 39, wherein the computer comprises a user interface for removing incorrectly recognized markers by the computer or for adding the position

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coordinates of the markers with reference to the digital images, for the markers which the computer failed to recognize.

41. An apparatus for calculating postural deviation values in a patient comprising:
- a) position data acquisition device for identifying a position in space of body segments of the patient while standing relaxed and in normal posture, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles;
 - b) weight data acquisition device for obtaining weight data of the patient;
 - c) vertical and horizontal plumb lines determination device using the position data;
 - d) angle of deviation and distance of deviation determination device for determining at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data.
42. The apparatus of claim 41, wherein said angle of deviation and distance of deviation determination device refers said angle and distance of deviation values with respect to average or normal values.
43. The apparatus of claim 41, further comprising an effective weight or stress determination device for determining an effective weight or stress of at least one of the body segments using an estimated weight of the at least one body segment and the deviation values.
44. The apparatus of claim 41, wherein the determination device calculates deviation values for all of the body segments.
45. An apparatus for selecting exercises for improving tonicity and correcting posture in a patient, the apparatus comprising:

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a) a biomechanical position data acquisition device for obtaining biomechanical position data of the patient while standing relaxed and in normal posture, the position data being indicative of postural problems requiring corrections;

b) ranking means for ranking the postural deviations by severity and priority;

c) a correlator for correlating the position data with exercises for strengthening or stretching specific muscles or muscle groups to obtain ranking data for the exercises; and

d) a compiler for compiling an exercise program for the patient based on the ranking data.

46. The apparatus of claim 45, wherein the exercises are grouped in sets of exercises each attempting to correct a specific postural deviation, the correlator correlating the position data with the sets of exercises, and the exercise program comprises a series of the sets of exercises.

47. The apparatus of claim 45, wherein the position data identifies a position in space of a body segments of the patient, the body segments comprising head-shoulders, shoulders-pelvis, pelvis-hips, hips-knees and knees-ankles, and the correlator comprising:

a) a center of mass plumb line position determination device for determining a center of mass plumb line position value using the position data and the weight data;

b) a angle of deviation and distance of deviation determination device for determining for at least some of the body segments an angle of deviation value and distance of deviation value with respect to the plumb line position value using the position data;

c) a deviation values comparison means for comparing the deviations values to normal values for the at least some of the body segments to obtain deviation priority values;

d) ranking means for ranking the deviation priority values according to an order of severity or importance; and

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e) a ranking data with body segment deviations determination device for determining the ranking data based on an association of the exercises with body segment deviations in accordance with the order of severity or importance.

48. The apparatus of claim 47, wherein said ranking means performs ranking of the deviation priority values accordingly to an order of severity or importance comprising manually selecting deviations to be corrected by the exercise program, the order of severity or importance reflecting those deviations manually selected.

49. The apparatus of claim 48, wherein said compiling means is repeating ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

50. The apparatus of claim 49, wherein said compiling means further include ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

51. The apparatus of claim 48, wherein said compiling means repeat ones of the exercises corresponding to most severe postural problems regularly throughout the exercise program and including ones of the exercises corresponding to less severe postural problems for only part of the program.

52. The apparatus of claim 51, wherein said compiling means further include ones of the exercises corresponding to moderately severe postural problems more intensively for only part of the exercise program.

53. The apparatus of claim 45, further comprising:

- effectiveness of the exercises evaluator for evaluating an effectiveness of the exercises in the exercise program for correcting the postural problems based on new biomechanical position data of the patient obtained while standing relaxed and in normal posture after completion of the exercise program; and

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- parameters adjustment means for adjusting parameters used in correlation for future patients based on the effectiveness evaluated.

54. The apparatus of claim 53 further comprising a centralized shared database used for correlating, evaluating and adjusting for a large number of patients.

55. An apparatus for providing posture health care using a distributed system comprising:

a) a personal data obtainer for obtaining personal data of a patient, the personal data including weight, height, gender and activity data of the patient, and obtaining posture anatomical reference position data of the patient at a biomechanical measurement station;

b) a personal and position data processor for processing the personal and position data using data stored in a remote central database to obtain preliminary postural deviation assessment data;

c) a preliminary postural deviation provider for providing the preliminary postural deviation assessment data to one of a health-care practitioner and the patient;

d) a corrected postural deviation assessment data obtainer for obtaining corrected postural deviation assessment data from one of the health-care practitioner and the patient; and

e) a data modifier to modify the data stored in the central database using the corrected data.

56. The apparatus of claim 55, wherein:

said preliminary postural deviation assessment data comprises a set of therapeutic exercises of an exercise program;

said corrected data comprises new posture anatomical reference position data of the patient obtained after completion of the exercise program; and

said data modifier comprises processor for processing the new reference position data to determine an effectiveness of the therapeutic exercises in correcting postural deviations and modifying accordingly the data stored in the central database.

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57. The apparatus of claim 55, wherein:

said personal data acquisition device comprises validation means for validating completeness of the reference position data at the biomechanical measurement station and transmitting the personal and position data to a central server;

said personal and position data processor is at the central server;

said preliminary postural deviation provider comprises transmitting means for transmitting the preliminary postural deviation assessment data from the central server to one of the health-care practitioner and the patient;

said corrected postural deviation assessment data acquisition data comprises transmitting means for transmitting the corrected data to the central server; and

said data modifier is at the central server.

58. The apparatus of claim 57, wherein said client station uses a web browser interface to communicate with the central server, the central server providing a secure connection to a biomechanical assessment report web document for the patient.

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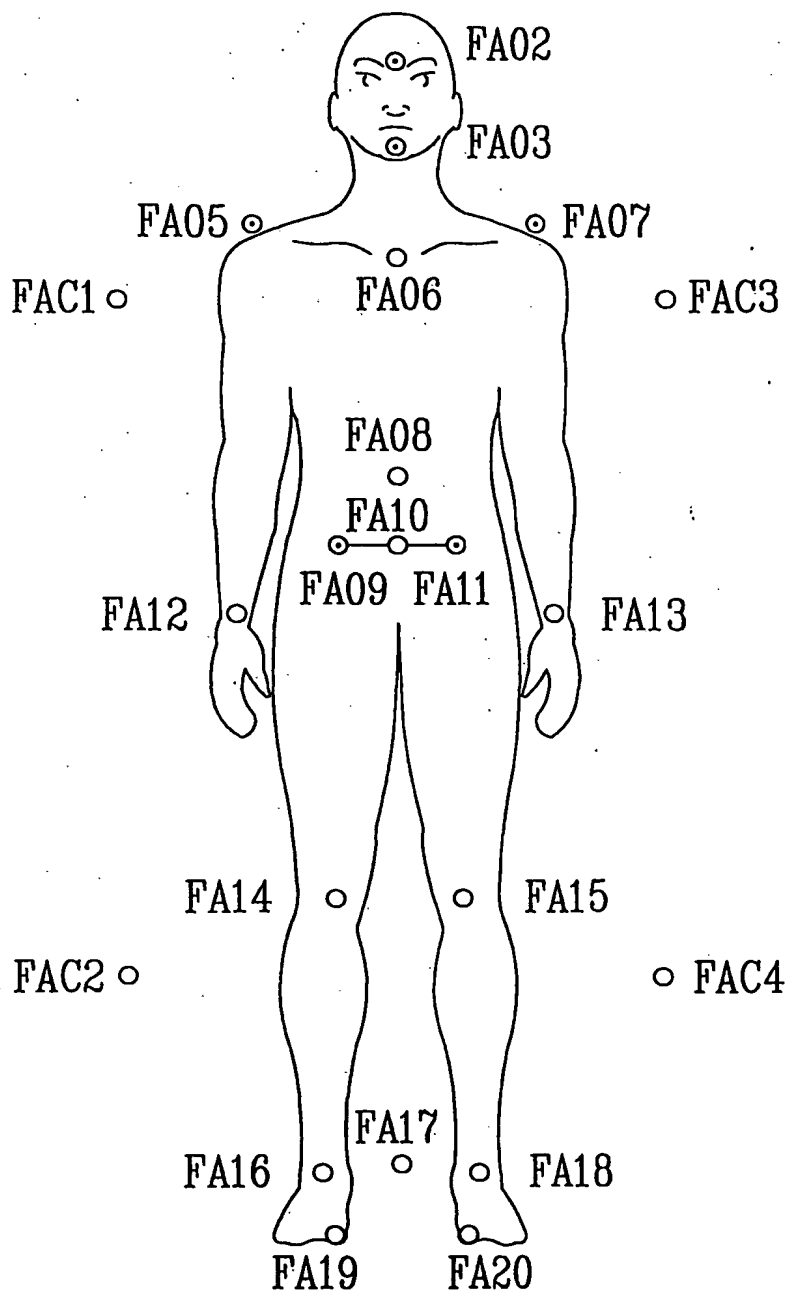


FIG. 1

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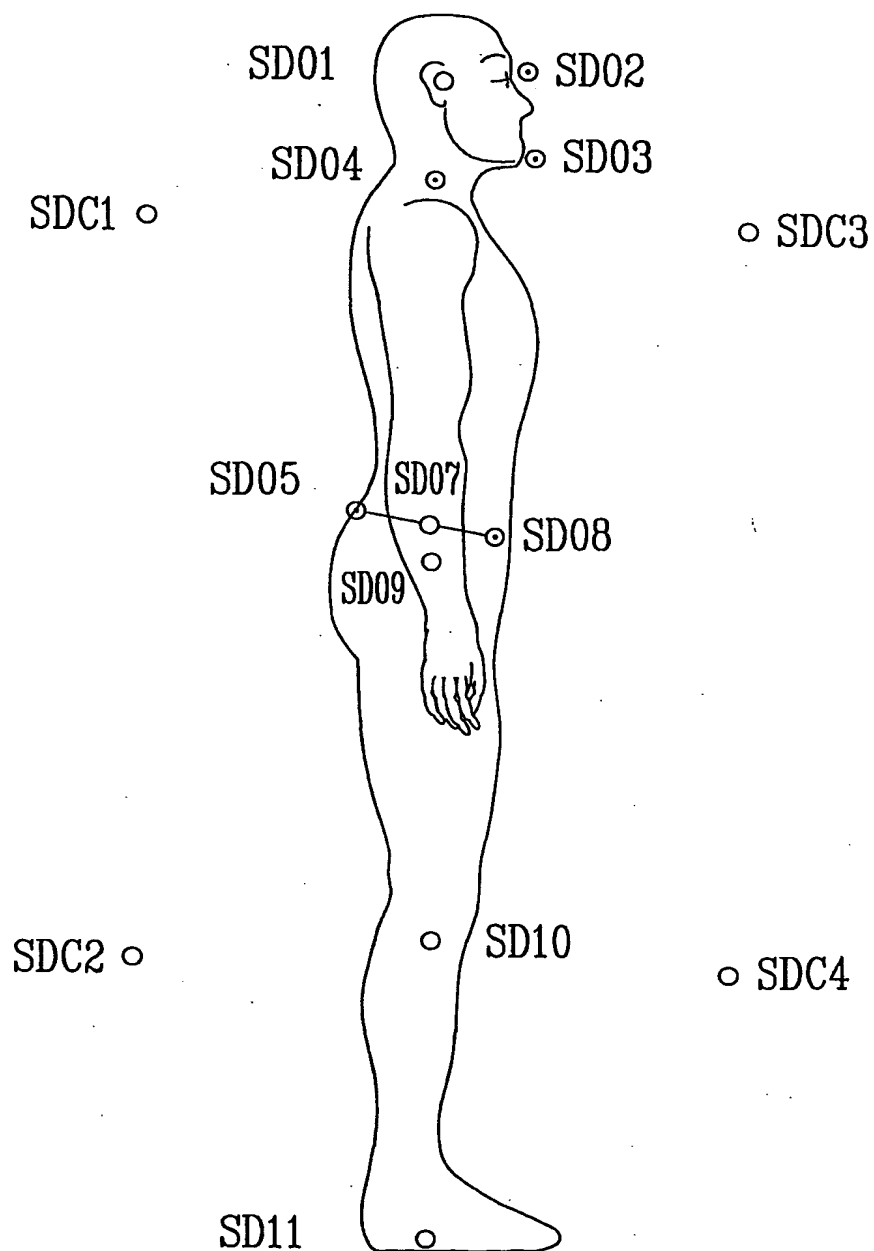


FIG. 2A

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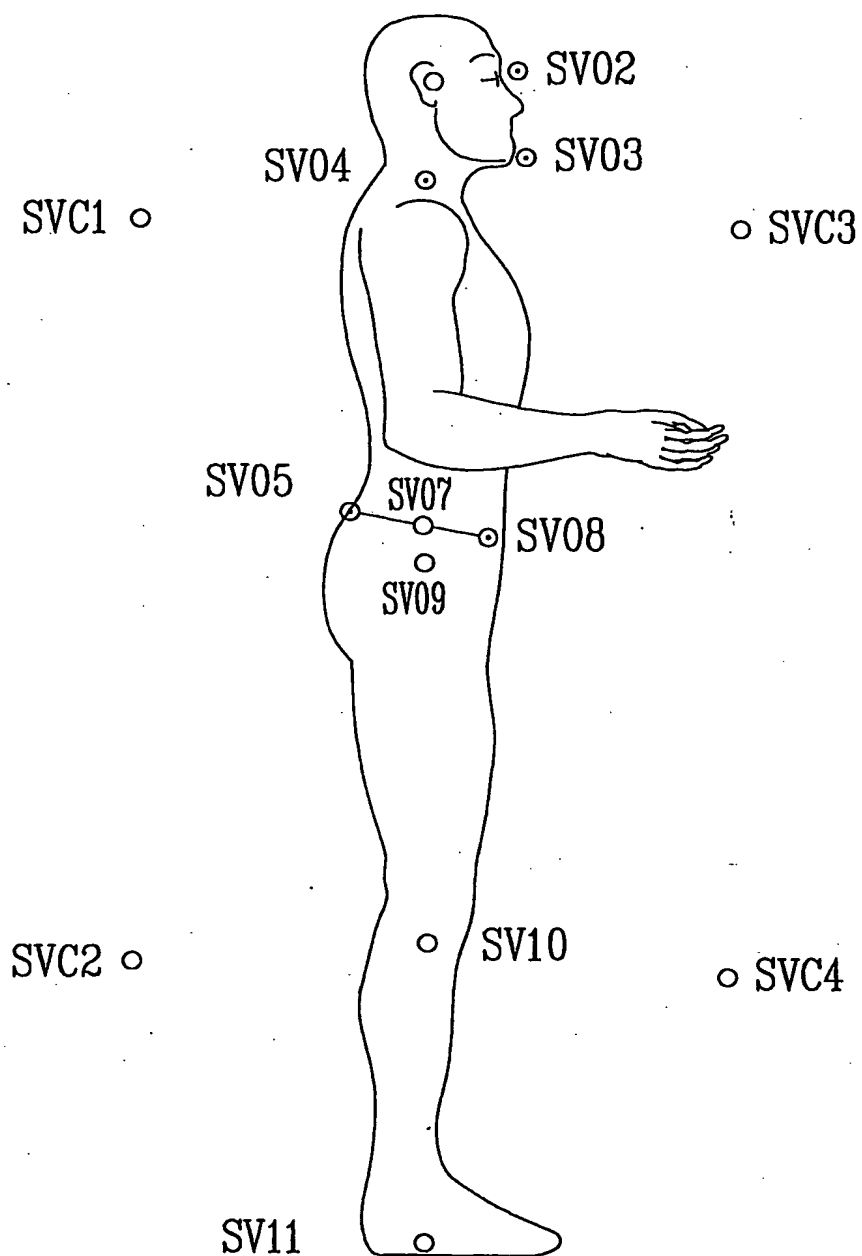


FIG. 2B

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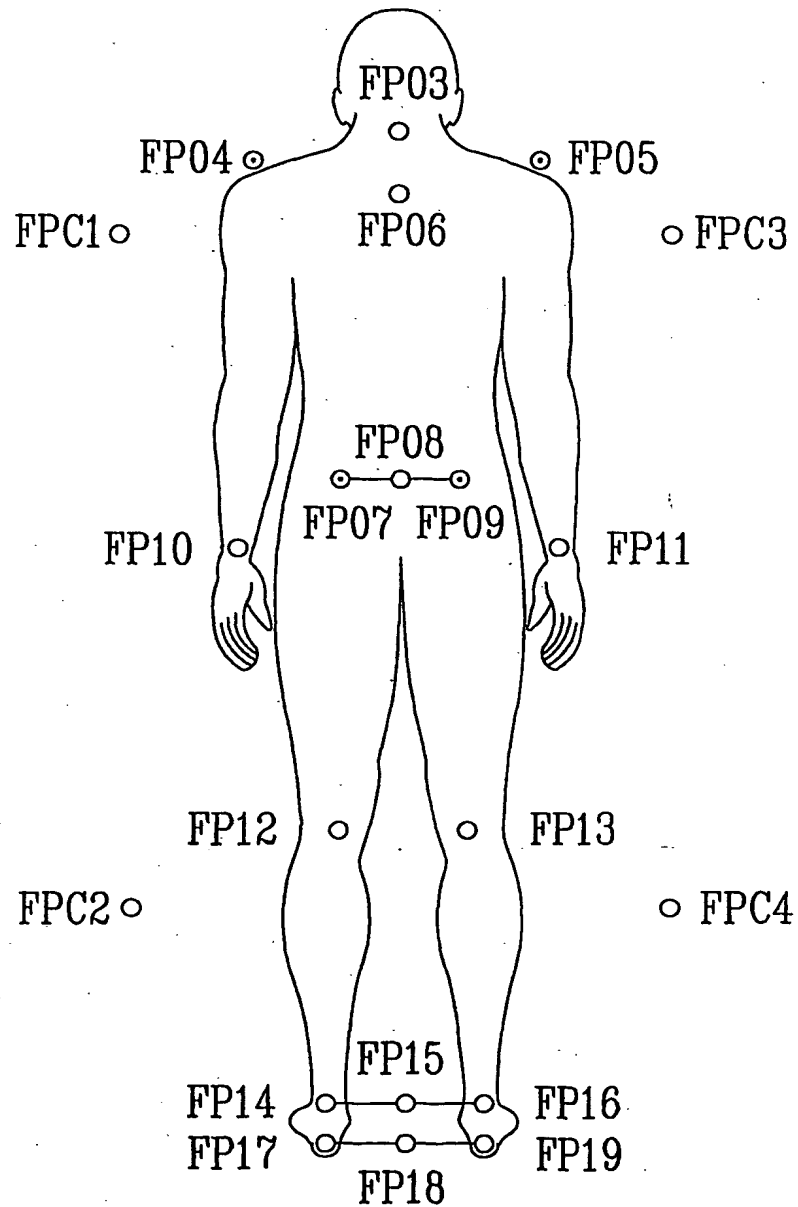


FIG. 3

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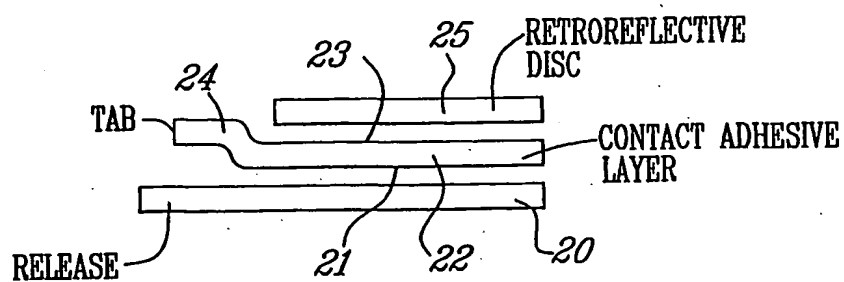
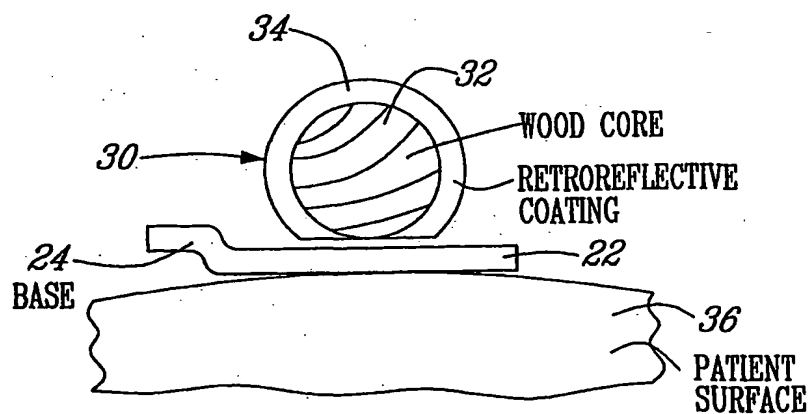


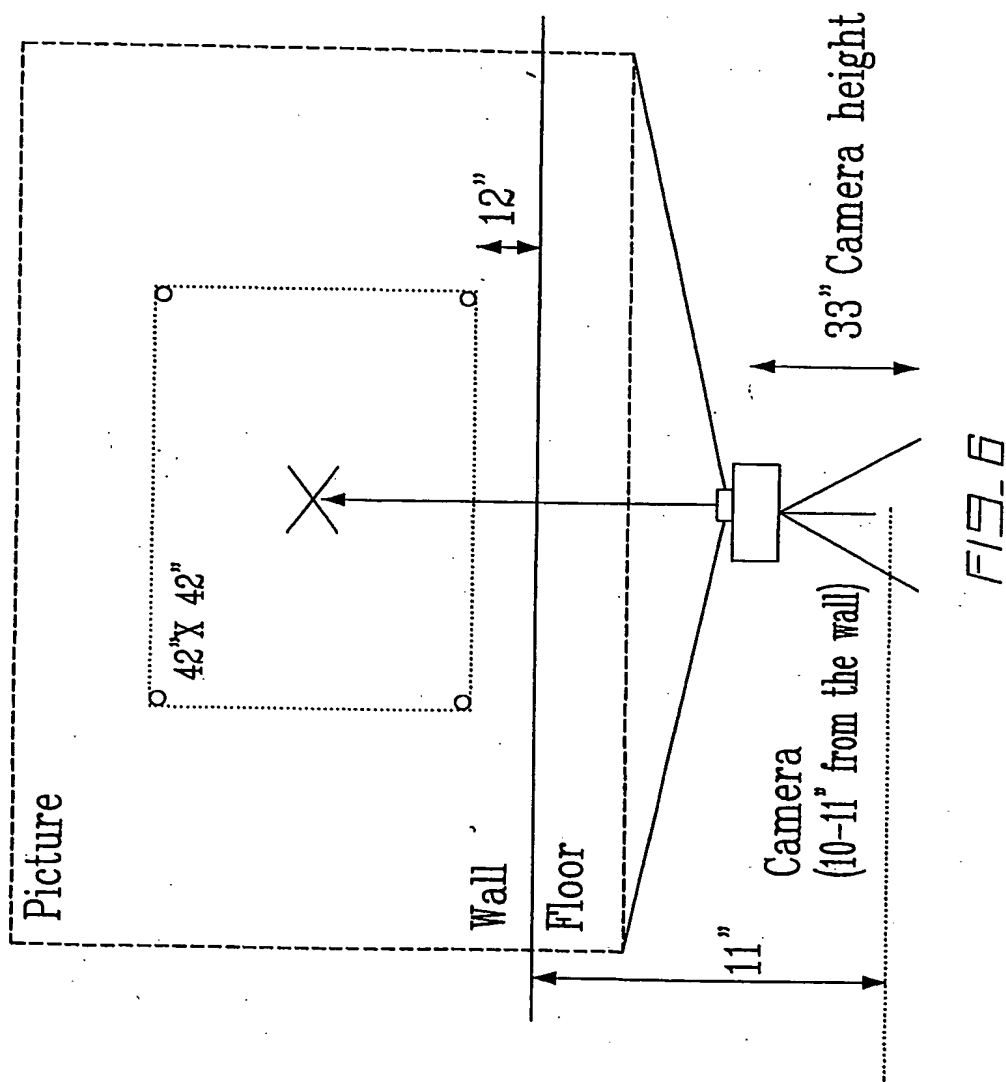
FIG. 4



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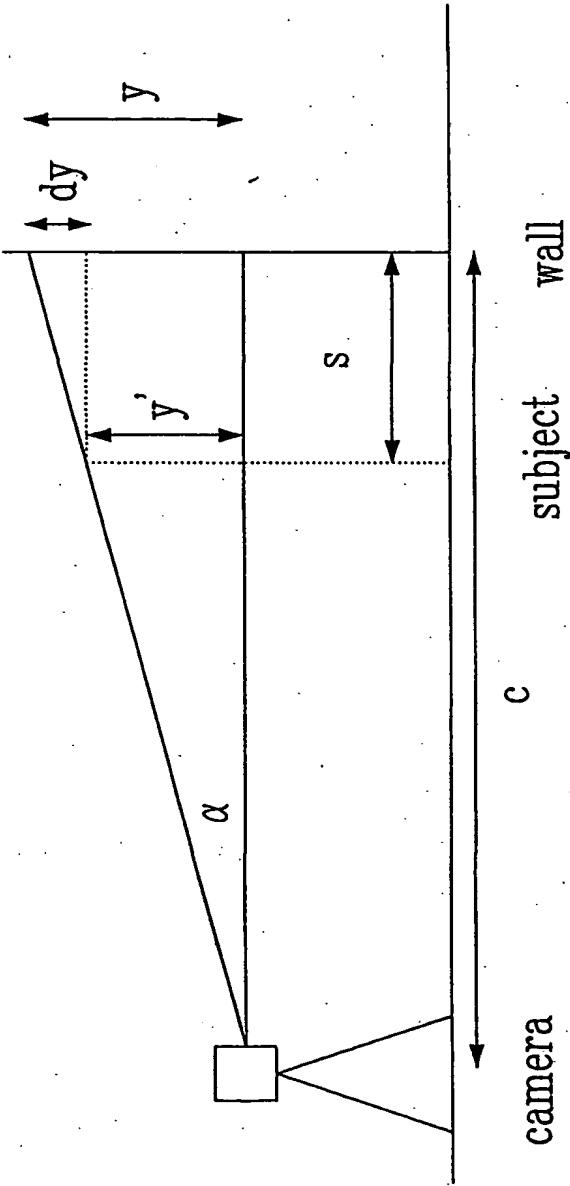


FIG. 7

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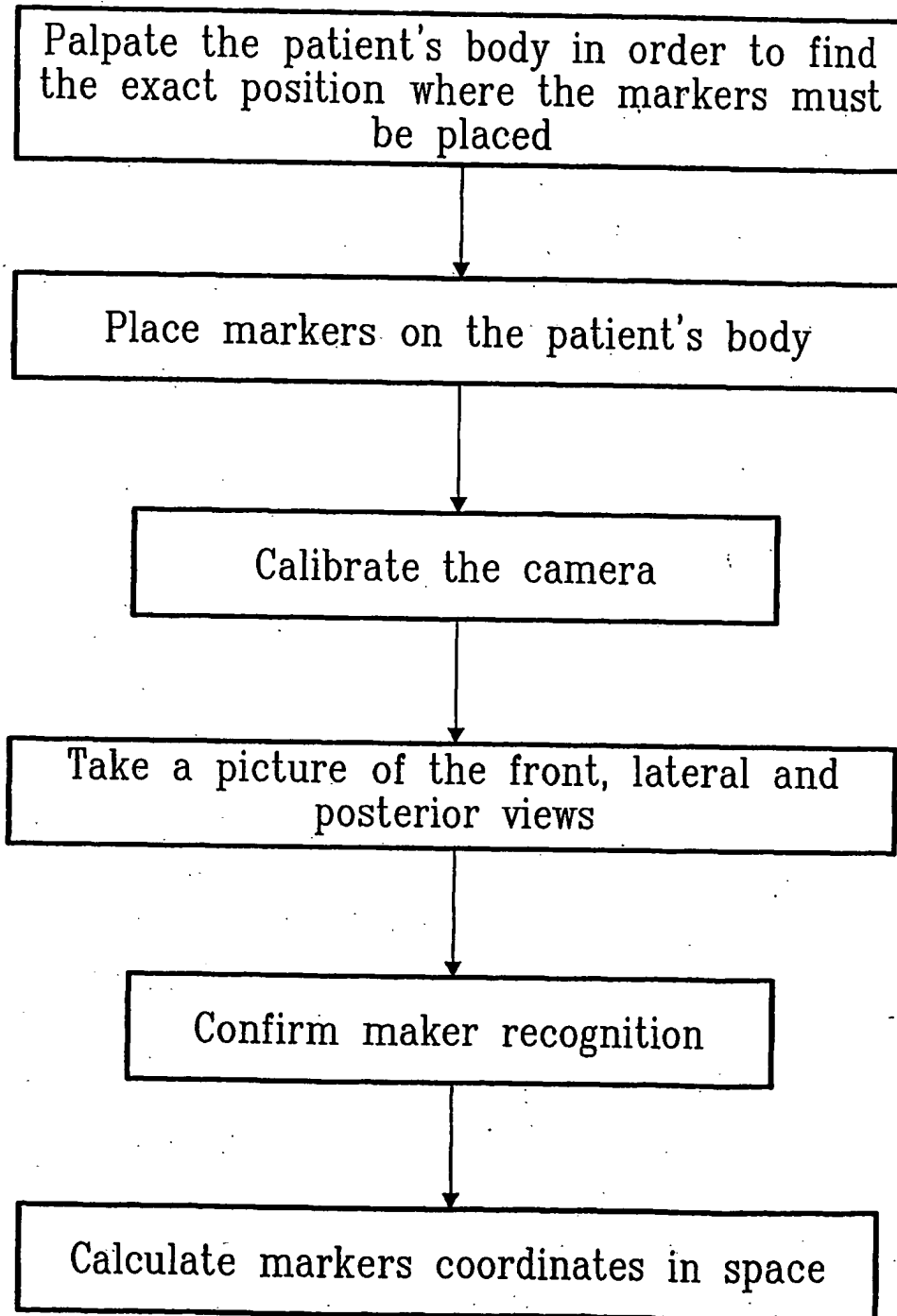


FIG. 8

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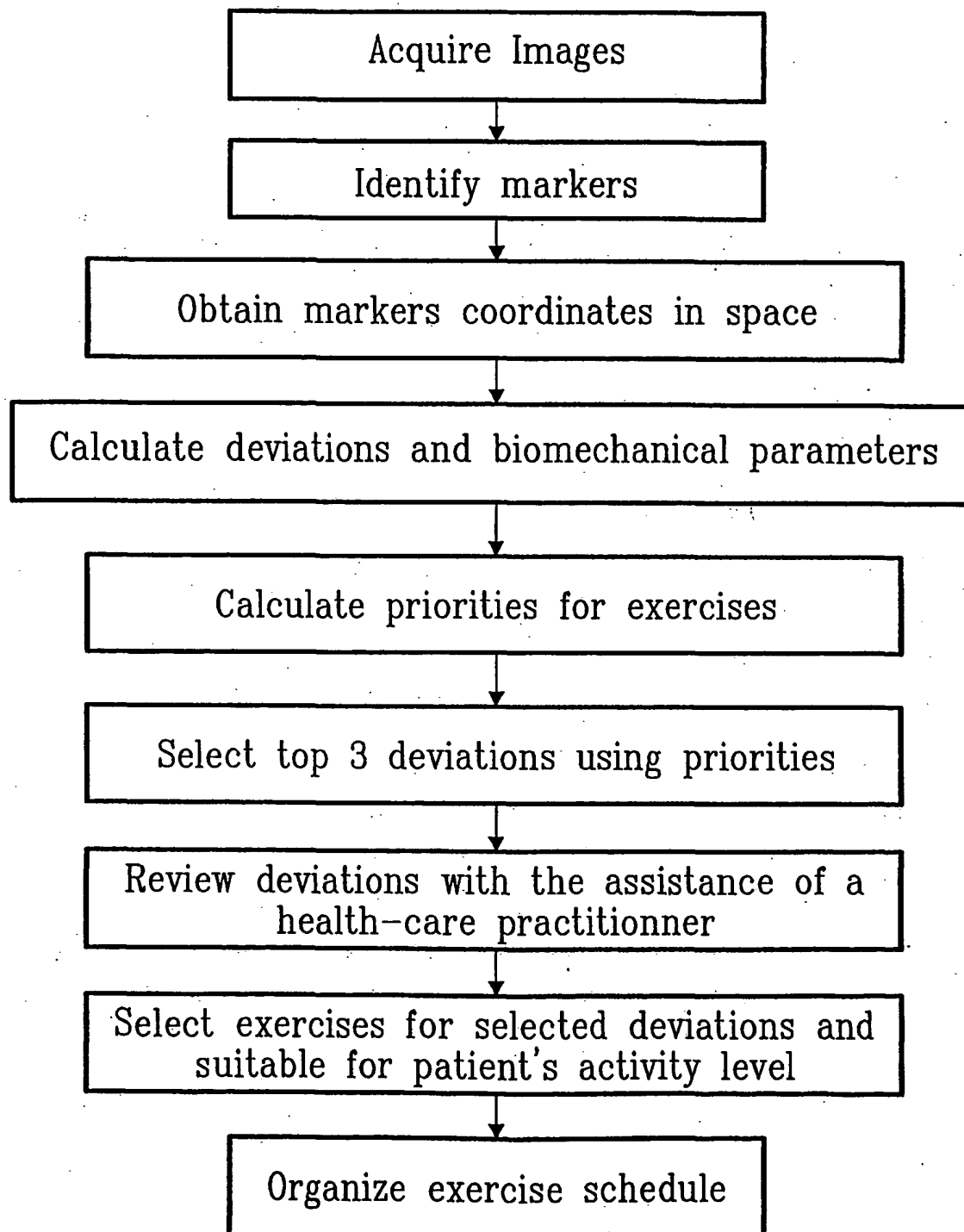


FIG. 9

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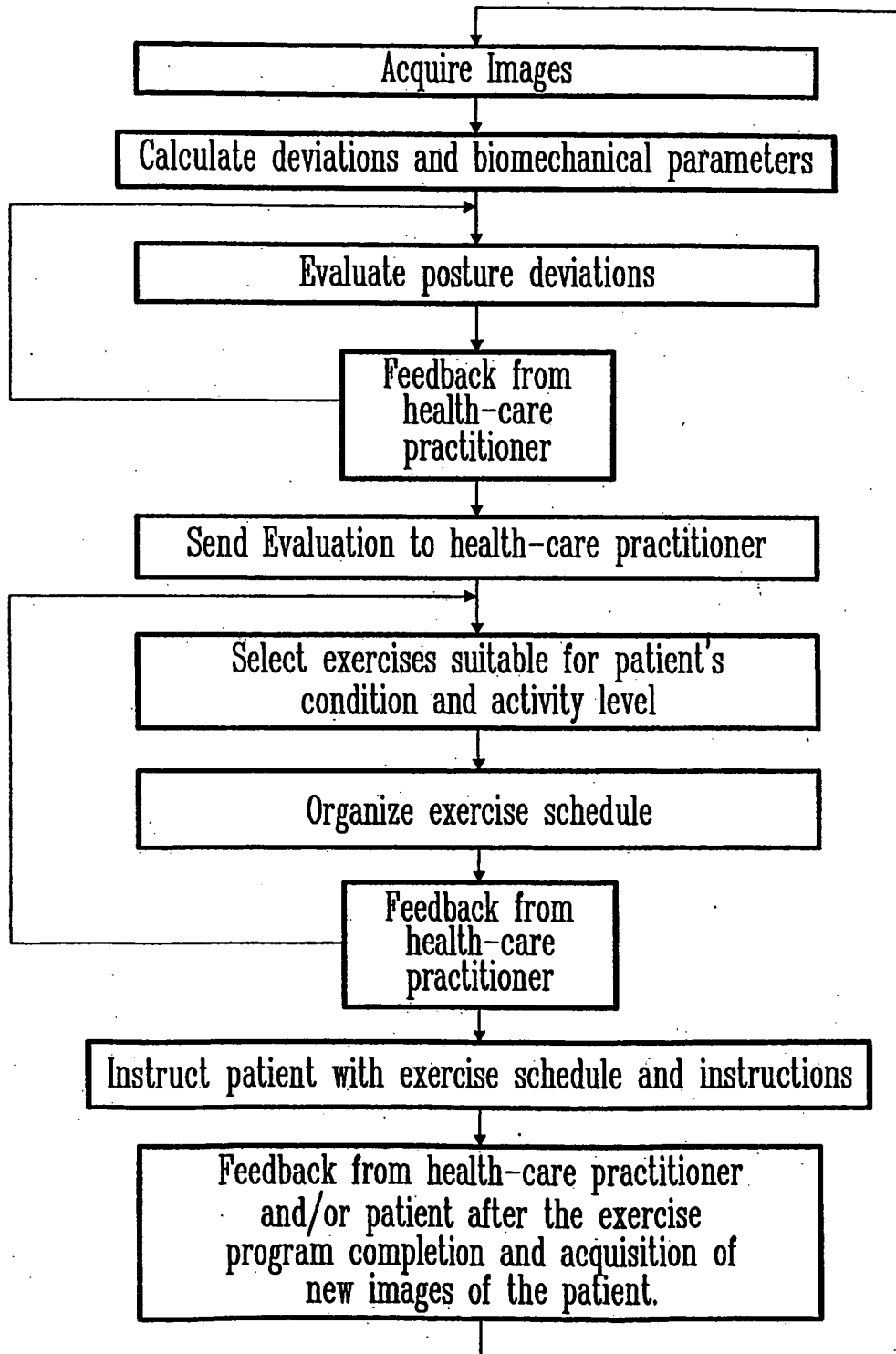


FIG. 10

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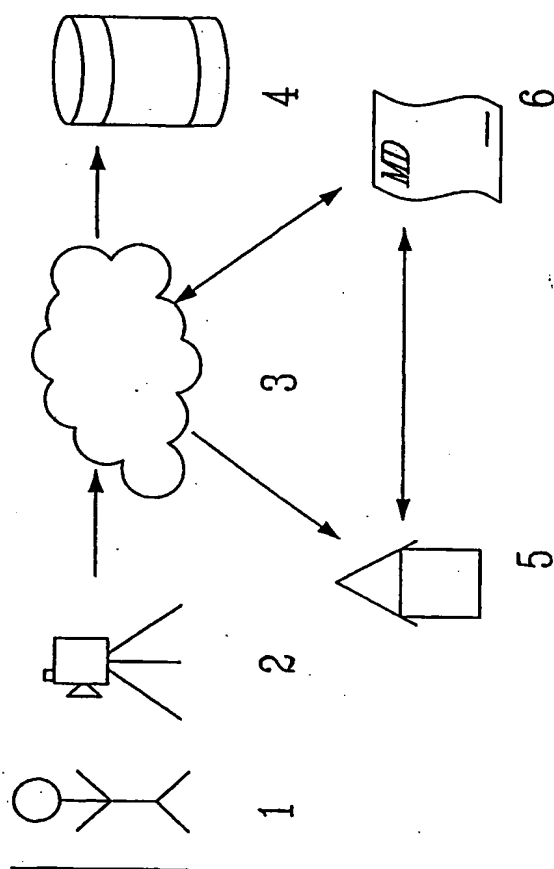


FIG. 11

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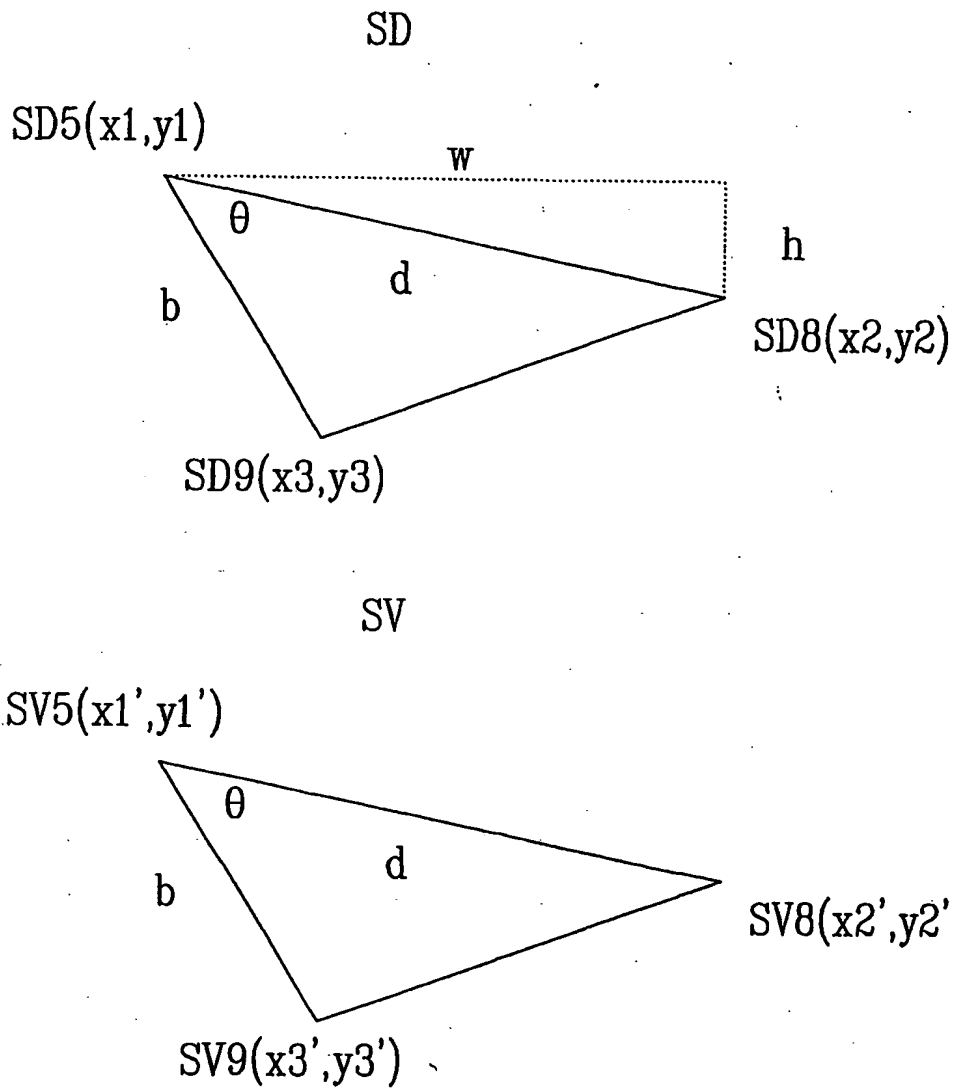


FIG. 12

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Identification

User ID : jf1708200002
 Name: Posterior Head Translation
 Birthdate : Thursday, January 01, 1970
 Sex: Male
 Height : 67.0 in
 Weight: 170.0 lbs
 Activity Level: Inactive

Evaluator : Jean-Francois Normandin

Lateral View

Deviations from Vertical Alignment

Segment	Direction	Angle
Head to Shoulders	Posterior	8.5 °
Shoulders to Pelvis	Anterior	3.8 °
Pelvis to Hips	Posterior	13.0 °
Hips to Knees	Posterior	1.5 °
Knees to Feet	Anterior	2.9 °

Note: The ideal angle should be 0°.

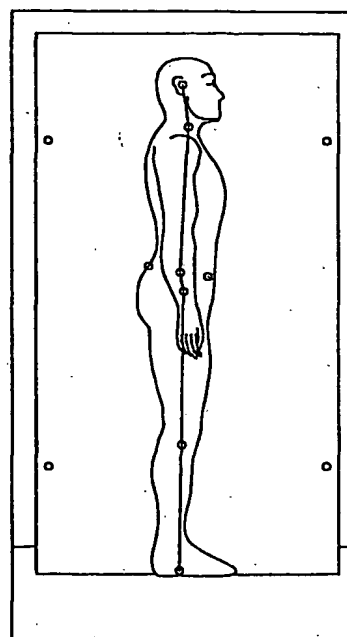
Distances from the Vertical Axis

Reference Point on	Direction	Distance
Head		0.0 in
Shoulders	Anterior	0.7 in
Pelvis	Posterior	0.4 in
Hips	Anterior	0.4 in
Knees	Anterior	0.8 in

Note: The ideal distance should be 0 in.

Moments of Force and Reaction Forces

Segment	Actual weight	Lever arm	Moment of force	Joint reaction force	Effective weight
Head	14.3 lbs	0.7 in	-1.2 Nm ↺	92.8 N	20.9 lbs
Head and Trunk	113.6 lbs	0.4 in	5.3 Nm ↻	611.5 N	137.6 lbs



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Postural Deviations and Associated Exercises and Stretching

Postural Deviation		Movement	Action	Recommended by
Posterior pelvic tilt	1	Hip Extension (left)	Stretch	System
	2	Hip Extension (right)	Stretch	System
	3	Hip Flexion (left)	Contract	System
	4	Hip Flexion (right)	Contract	System
	5	Trunk flexion	Stretch	System
	6	Trunk lumbar extension	Contract	System
Translation of the head (right)	7	Neck head lateral flexion (left)	Contract	System
	8	Neck head lateral flexion (right)	Stretch	System
Extension of the head	9	Neck head extension	Stretch	System
	10	Neck head flexion	Contract	System
	11	Scapula Adduction	Stretch	System

FIG. 14

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Exercise and Stretching Schedule

Period	Name	Movement	Repetitions
Week 1-2	1 Hamstring stretch	1	3X 30 Sec.
	4 Hamstring stretch	2	3X 30 Sec.
	7 Squat	3,4	3x 10-15 Reps
	9 Cobra	5	3X 30 Sec.
	10 Prone lumbar extension with hands on the lower back	6	3x 10-15 Reps
	12 Cervical strengthening	7	10X 6 Sec.
	14 Left lateral flexion	8	3X 30 Sec.
	17 Forward neck flexion	9	3X 30 Sec.
	18 Cervical strengthening	10	10X 6 Sec.
	19 Scapula adductor stretch with your hands behind your back	11	3X 30 Sec.
Week 3-6	2 Hamstring stretch	1	3X 30 Sec.
	5 Hamstring stretch	2	3X 30 Sec.
	8 Unilateral squat	3,4	3x 10-15 Reps
	9 Cobra	5	3X 30 Sec.
	11 Seated lumbar extension	6	3x 10-15 Reps
	13 Supine cervical strengthening	7	10X 6 Sec.
	15 Supine lateral flexion to the left	8	3X 30 Sec.
	17 Forward neck flexion	9	3X 30 Sec.
	18 Cervical strengthening	10	10X 6 Sec.
	20 Scapula adductor stretch with your arms crossed	11	3X 30 Sec.
Week 7-10	3 Hamstring stretch	1	3X 30 Sec.
	6 Hamstring stretch	2	3X 30 Sec.
	8 Unilateral squat	3,4	3x 10-15 Reps
	9 Cobra	5	3X 30 Sec.
	11 Seated lumbar extension	6	3x 10-15 Reps
	13 Supine cervical strengthening	7	10X 6 Sec.
	16 Left lateral flexion with rotation to the right	8	3X 30 Sec.
	17 Forward neck flexion	9	3X 30 Sec.
	18 Cervical strengthening	10	10X 6 Sec.
	20 Scapula adductor stretch with your arms crossed	11	3X 30 Sec.

FLS 1.5

SUBSTITUTE SHEET (RULE 26)

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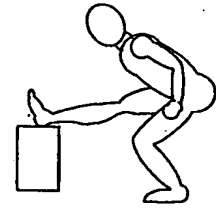
Exercises and Stretching

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1 - Hamstring stretch

Position

1. Place the heel of the foot of the working leg on a chair or something of equivalent height so that the leg is flexed at the hip and extended at the knee.
2. Gently flex the supporting leg at the hip and knee. Place one hand on the supporting leg's thigh and the other hand on the outer part of the working leg's thigh.



Action

Flex the supporting leg at the knee until you feel a pulling sensation in the working leg. Hold the stretch for the specified time, gradually relax and repeat as indicated.

Specific Objective

Improve hamstring muscle group flexibility (hip extensors, knee flexors).

Contraction type:

Static stretch

2 - Hamstring stretch

Position

1. Lie on your back with one leg flexed at the hip and knee, foot flat on the floor.
2. Flex the working leg at the hip and knee, and gently pull it in to the chest with your hands placed behind the knee.



Action

Pull the knee of the working leg in towards the chest, keeping the leg flexed at the knee. When you feel a pulling sensation in the back of the thigh, hold the stretch for the specified time, gradually relax and repeat as indicated.

Specific Objective

Improve hamstring muscle group flexibility (hip extensors).

Contraction type:

Static stretch

FIG. 16